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ABSTRACT

Conservation and environmental education activities comprise this manual for K-12 teachers in Oklahoma. Materials are grouped by subject matter: (1) Soil and Land Use; (2) Water; and (3) Habitat and Wildlife. Each chapter begins with background information designed as a short course for the teacher on the topic covered. This is followed by a set of lessons and descriptions of government agencies, private organizations, books, films, and other resources. Also included in the manual is a chapter on resource management practices and a chapter containing directions and case studies dealing with the development of outdoor classrooms. (WB)

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FOREWORD

Conservationists, environmentalists, and the general public are developing a strong interest in the use of Oklahoma's natural resources. With this interest has come the urgency that future generations of Oklahomans be provided with an awareness and knowledge of our natural heritage.

The Oklahoma Department of Education has developed a publication to assist schools in implementing an inter-disciplinary approach to Environmental and Conservation Education.

The publication includes topics that are essential for understanding by students. The instructional activities provide students direct interaction with the natural resources.

The compilations of background information, activities, and resources is a beginning for teachers. Studying nature, natural phenomena, and natural resources is a necessary component of educating future generations of environmentally literate citizens.

ACKNOWLEDGMENTS

The State Department of Education and East Central University is indebted to the many teachers who have contributed to this publication either by thought or by hard labor. The editing committee wishes to express to all teachers an appreciation for just being there as an inspiration to students and for the improvement of educational opportunities. Students must have the opportunity: to observe, to investigate, to make decisions and to solve problems.

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HOW TO USE THIS BOOK

In the teaching of Environmental/Conservation Education, it is essential that two factors must receive equal emphasis. These two factors are knowledge and attitudes. As teachers, we must make certain that students not only have a sufficient knowledge base to make enlightened decisions, but that those decisions are also based on an attitude of concern for the present and future generations. It is essential that you and I and our students realize that the decisions and choices that we make today will in a large part determine the nature of the environment inherited by our grandchildren. These are appropriate goals for all classrooms.

This guide provides some examples of ways that you can deal with both factors in your classes. Chapters are grouped by subject matter, thus if you wish to teach about water, turn to that chapter. The first part of the chapter is a short course for you on the topic. In brief form, the content will be described for you. This will be followed by a section regarding values that can be taught about the topic. The next section is a collection of lessons and activities about the topic. These lessons are ordered from grades K-12. All topics

will not have lessons and activities at each grade level but have enough samples for you to use directly or modify for your class. Remember, these are only samples and many more are available. The last part of the chapter is a listing of resources. The first list is a people list. These are people near you who are eager to help and are only waiting for you to call. Use this list first! In addition, listings of books, pamphlets, films, free materials, and other teaching aids are included.

Remember that the greatest resource in your classroom is YOU! This book is only a place to start. Good luck.

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CHAPTER I - SOIL AND LAND USE

Soil along with water and air is our most important natural resource and of the three is perhaps the most misused. As man moved across this country, the objective was to "conquer the land." Today many of the same unsound attitudes and practices lead us to waste and abuse this precious resource.

In public schools the study of soils is made up of two primary components, the study of soil characteristics and the proper utilization of soils based on those characteristics. This background information should give you the necessary content to start soil studies in your classroom, but be sure to check the section on resources at the end of this chapter for more help and information.

Soil Formation

The process of soil building started at the time that the earth began to cool and continues today. The process proceeds slowly with the erosion of rocks into parent material. There are primarily two groups of agents which erode rocks. The first are mechanical factors such as water and wind, thermal expansion and contraction, organic factors such as plant roots growing in

cracks, and in some areas the grinding away of rocks by glaciers. The second are chemical factors such as the breakdown of soluble minerals in rocks by water or the chemical changes brought about by living organisms.

When sunlight falls on a rock, a part of that light is absorbed and a part reflected. The amount of each depends primarily upon the color and texture of the rocks. A rough textured, dark colored rock will absorb more sunlight than a smooth textured, light colored rock. As the sunlight is absorbed, it is changed into heat which causes the temperature of the rock to increase. As a material's temperature increases, it of course expands. Since it takes time for the heat to penetrate the rock, the change in temperature of all parts of the rock is not uniform. The temperature of the outer part of the rock increases first and causes unequal expansion within the rock. This unequal expansion of the rock gives rise to stresses which over a period of time weakens the structure of the rock and causes it to crack and break apart. The process is reversed at night as the rocks cool more rapidly on the outside than in the interior.

After the rock has begun to crack, other eroding factors begin to act. Since the cracked rock has more surface exposed to the elements, there is more area for water to act upon and break down the soluble materials in the rock. In addition, plant roots may intrude into

the cracks and as they grow, cause the crack to become larger. Lichens may attach themselves to the rock and further break it down through acidic secretions as it obtains food from the rock minerals.

Water may flow across or through the rock, picking up the small weathered fragments and grinding them against other rocks into finer and finer particles. The wind may have the same effect but will operate on much smaller rock particles. As you have probably guessed by now, the climate is the most important factor in determining which of the eroding factors will have the greatest effect.

These small rock particles are now the basic foundation of soil building and are called parent materials. As you can imagine, the time required for parent materials to form is quite long. It is also important to remember that this entire process is in effect today.

After the parent material forms the soils develop from these materials. The type of soil which forms depends upon the combination of the following five factors: (1) parent materials; (2) climate; (3) living organisms; (4) local topography; and (5) time. Each factor is extremely important in regard to the type of soil which forms.

Parent Materials

Some rocks from which parent materials are formed have large coarse grains while others have very fine grains. The soil formed from the coarse grained parent material will naturally have a more open sandy texture while the fine grained parent material will give rise to a more compact soil.

In addition, rocks such as sandstone are made up primarily of insoluble materials such as quartz, while a rock such as limestone or marble contain large quantities of calcium and magnesium carbonate which over the years are dissolved by water.

Granite and Basalt may have either large or fine grains, but both have relatively large amounts of quartz and form soils which are loams or sandy loams mixed with fine clay particles.

Slate and shale have very fine particles which normally produce heavy soils. These soils are normally formed rapidly as both materials break down relatively quickly.

Sandstone and quartzite generally produce very sandy infertile soil containing mostly insoluble quartz particles and little plant nutrients.

Limestone and marble give rise to rather fine textured soil which is generally quite rich in nutrients.

Some soil does not have a rock parent. Peat soils are an example of these. The parent material is peat

moss which normally occurs in swamps or bogs. Peat soils are very rich in plant nutrients.

The particle size of the parent material will also determine how well water will move through the soil and consequently the amount of leaching which will occur. Leaching is the process whereby soluble materials are dissolved by water and move in solution through the soils into streams, lakes, or oceans.

As the genetic makeup of your parents influenced your characteristics, so will the characteristics of the parent materials influence the type of soil which forms. But just as you are not totally a product of your genetics, the soil type is not totally determined by parent materials.

Climate

The climate existing in the locality of the parent material will also greatly influence the type of soil which is formed. A very humid climate will accelerate the dissolving of the soluble compounds in the parent material, causing them to be more thoroughly leached. Since the soluble materials are likely to be basic, the soil formed will tend to be acid. Since soils formed in dry climates will experience less leaching, the soil is more likely to be alkaline.

Soils which form in cold climates are likely to contain more organic materials (pieces of dead plants

and animals) since the decomposition process is slowed by the cold.

Soils in tropical areas will be affected by plant and animal activity in the soils whereas soils in a desert region would show little evidence of organic activity.

Wind would have little effect on soils forming in a wet climate whereas in an arid region, the wind would be a significant factor.

Living Organisms

Plants put down roots in the forming soils, taking nutrients from the soil in order to grow. As the plants die, their remains become a part of the soil and influence the soil characteristics. Heavy plant growth would of course tend to help produce a soil rich in organic materials. Both the type of parent material and the climate determine the type and quantity of plant growth. The three factors, parent materials, climate, and plants are so closely intertwined that if either of the two are known, the other can be predicted.

In addition to plants, both microscopic and macroscopic animals live, grow, reproduce, and die in the soil. Like plants, they too are dependent upon the climate and parent materials. The animals obtain food both from the minerals in the parent materials and from the living and dead plants. These animals cause chemical

changes in both the parent materials and the organic materials in the soil.

Local Topography

As soil forms, distinct layers or horizons form. This is due to the leaching effect of water moving downward through the soil. The more water which percolates through the soil, the more leached the soil becomes, and consequently the more distinct the horizons. Simple logic tells us that the steeper the location in which the soil is forming, the more rapidly water runs off. This of course does not allow the water time to percolate into the soil, and in addition erodes the soil quite rapidly. As a result, the soil developed in such a terrain is eroded away as rapidly as it is formed so the resultant soil is quite young. Since little percolation occurs, the horizons are quite thin or even non-existent.

The same reasoning tells us that soils which form in low flat areas will have not only more water percolating through but also more time for that to happen and will then have thick, distinct horizons characteristic of mature soils.

Soils formed from the same parent materials in the same climate but on different degrees of slope will be quite different.

The sunny side of a slope will produce different type plants than the shady side and will as a result produce a different soil.

Time

Soil is like people in that as it gets older, it changes. The maturation process for soil is primarily leaching. If the soil can remain in place for a long enough period of time, the amount of leaching stabilizes and a mature soil characterized by thick distinct horizons results. If the parent material is sandstone in a tropical area with gently sloping terrain, this process may take place in one to two hundred years, while in an unglaciated limestone area, thousands of years may not be enough.

The soils of the earth range in age from a few years to a few million years. Generally speaking, the older a soil is, the more leached and less fertile it becomes.

It's only common courtesy that anything as old as soils have our respect.

Soil Composition

Soils are composed of four distinct and easily identified elements: air, water, organic materials (living and dead plants and animals), and minerals (from parent materials). The average soil is 45% minerals, 25% water, 25% air, and 5% organic materials. Soils in arid regions will have a higher percentage of minerals and air while soils in humid regions may have more water and organic materials. Peat soils may be almost pure minerals and air.

SOIL AIR COMPOSITION

GAS	PERCENTAGE	
	ATMOSPHERE	SOIL
Oxygen	20.99	20.3
Carbon dioxide	0.04	0.5
Nitrogen and other gases	78.97	79.2

Normal soils contain at least three distinct layers. At the surface is the top soil which is usually more open in the texture than the soil at a deeper level. The majority of the organic materials found in soils are in the top soil. The topsoil may range in depth from a few centimeters up to several meters in depth depending upon the five factors influencing soil building. The nutrients needed by plants are usually found in the topsoil and generally good topsoil is necessary for most plant growth. Most of the soil which erodes away into streams, lakes, and oceans is topsoil. Though it may take up to a hundred years or more for a few centimeters of topsoil to form, it can all be eroded away during a single rain shower falling upon an unprotected, sloping field. One of our most important concerns should be to protect the topsoil.

The next layer is the subsoil. This layer is usually lighter in color due to a lesser amount of organic materials and has a finer texture, normally tending toward silt or clay.

Underneath that is the parent material which is composed of the small pieces of weathered rock from which the soil originally formed. This layer of parent material is normally located on top of a foundation of bedrock.

All soils have characteristics which determine the uses for which they are best suited. Perhaps the most important part of soil studies is determining the uses for which the soil is best suited. The remainder of this background information will be an overview of some soil characteristics and their implications for the use of the soil.

Soil Characteristics

Soil, like any other form of matter, has many characteristics. The classification of a particular soil is an indication of those characteristics. The purposes for which a soil is best suited is a function of its collective characteristics. Several characteristics of soil will be considered in this section with emphasis on the implicating of these characteristics in terms of the utilization of the soil.

Soil Color

Color is of course the most obvious soil characteristic. A soil's color is primarily dependent upon two factors, the first being the type of rocks from which the soil formed, and the second being the amount of organic materials present in the soil. Soils formed from rocks having a high iron content will have a reddish color, while a soil formed from basalt may tend toward a dark grey or black. Soils formed from rocks which are primarily quartz are likely to have a grey to off-white color. Organic material contributes to the brown and black colors of the soil.

Color then can be an indicator of soil fertility, but it is not the most valid indicator. However, it can give us an idea of the amount of sunlight which will be absorbed by the soil and thus is an indicator of the heating and cooling characteristic of the soil. A dark colored soil will absorb more sunlight than a light colored soil, and as a consequence, its temperature will increase more rapidly.

Soil Texture

The texture of the soil is a function of the amount of organic material in the soil and the size of the soil particles. The table below gives a list of the dimensions in millimeters of various soil particles. Remember that a millimeter is about the diameter of the lead in a pencil.

SIZE	DIAMETER (mm)
Gravel	Greater than 2.0
Coarse sand	2.0 - 0.2
Fine sand	0.2 - 0.02
Silt	0.02 - 0.002
Clay	Less than 0.002

The texture of a soil affects its stability and susceptibility to erosion and its water absorbing and holding capabilities. The soil texture should be a prime consideration in deciding the best use for a soil.

Non-Living Organic Content

The non-living organic materials in the soil are an accumulation of dead plant and animal materials. As plants die, their remains will break down and become a part of the soil. As stated previously, this organic material is the major source of phosphorus and sulfur and is the sole source of nitrogen in the soil. The non-living organic material in the soil largely determines the soil fertility and is an important factor in determining the best soil use.

SEEING AND MEASURING EROSION

Soil lost in the erosion process means damaged land - land that can no longer grow healthy plants. This same soil causes damage as it gets into ditches, streams, reservoirs and navigable waters.

Build a hill to study the erosion process and to investigate what can be done to stop erosion. The hill can be as small as 2 feet by 2 feet and only a foot high - or it can be larger. Measure the exact slope in degrees and percent. Sprinkle known amounts of water on various kinds of cover. Or use different conservation practices like contouring or terracing to show how they affect erosion.

Get more sophisticated if facilities are available. Build your hill to have a slope about 15 feet long. Use the following to calculate soil loss in tons per acre:

The rill method of measuring erosion provides data on soil lost by water erosion. It is useful in measuring the effectiveness of conservation practices and treatments. The soil loss in tons per acre (T.P.A.) equals the cross section area of the rills in square inches when measured in a strip 13.7 feet long.

1. Choose a representative strip at right angles to the general direction of the rills (across the slope).

2. Measure off a distance of 13.7 feet (13 feet, 8½ inches).
3. Measure the average width (top plus bottom - divided by 2) and the depth of each rill along the line and tabulate.
4. Compute the area of each rill in square inches and the total area of all rills in the sample strip. This total area in square inches equals the T.F.A. loss.

In addition to the conservation lesson, these exercises involve the use of mathematics.

Also investigate what happens to soil after it washes from your school ground hill.....and the many similar hills in your neighborhood.

SOIL TEMPERATURE

Soil temperature varies with depth, season, soil type, time of day, light intensity, and moisture content. The temperature range in soil affects the distribution of organisms within it. As a result, temperature readings can assist you in analyzing why a population of organisms is found in a particular soil.

The following method will help you to compare temperatures taken at various sites.

Materials: Soil thermometer

Procedure: Select a site where the depth of the various soil layers is known.

Read the air temperature and record it.

Read the soil temperature at the soil surface and at depths of 5 cm, 10 cm, 15 cm, and 20 cm. Record the results.

Repeat this procedure on several days in the morning, at noon, and in the late afternoon.

Repeat this procedure to compare shady and open areas, north and south slopes of a hill, areas where conditions are wet, dry, or damp, and areas where soil types differ. In doing this, be sure that all variables except the one being observed are constant. For example, when comparing the temperatures on north and south slopes, make sure that the soil types, the moisture content, the depths, the light intensity, and the time of day are approximately the same.

Discussion: Do the soil and air temperatures vary greatly? How did the soil temperature vary with depth? Was there variation in your readings with regard to the time of day they were taken? Did the amount of shade affect the temperature at all levels of soil? In which types of soils did you observe the greatest temperature fluctuation? The least fluctuation? How does moisture content appear to affect soil temperature?

WATER-HOLDING CAPACITY OF SOIL

The water-holding capacity of soil is mainly dependent upon two things--how much humus is in the soil, and the size of the soil particles. Although some soils can absorb their own weight or more in water, ideally the water content should be only 60-80% of the soil's capacity. If soils contain less than 60% of their capacity for water, there is not enough water for the cellular needs of many organisms. If soils contain more than 80% of their capacity for water, there is too little oxygen available for the growth and activity of many microorganisms.

Materials: A can with both ends removed, one end covered with filter paper, held in place by a rubber band

Sample of oven-dried soil

Procedure: Weigh the can with the attached filter paper. Record the weight.

Place the oven-dried soil in the can. Reweigh it.

Slightly moisten the filter paper on the end of the can.

Weigh the completed apparatus. Record its weight.

Set the can (filter paper end down) in water, so that the lower half is immersed. Leave it for 14 to 16 hours (overnight).

After this time, remove the can from the water. Transfer it to a rack where it can drain for approximately 30 minutes.

Wipe the surface of the can dry and weigh it. Record the weight.

Calculations: Using the following relationships, calculate the percent water-holding capacity of your soil sample.

- a.
$$\frac{\text{weight of water-soaked soil + apparatus} - (\text{weight of oven-dried soil + apparatus + wet paper})}{\text{weight gained by water absorption in soil}}$$

b.
$$\frac{\text{weight of dry apparatus + oven-dried soil} - \text{weight of dry apparatus}}{\text{weight of oven-dried soil}}$$

c.
$$\frac{\text{weight gained by water absorption in soil}}{\text{weight of oven-dried soil}} \times 100 =$$

percent water-holding capacity of the soil

Discussion: How much water should have been added to your sample of oven-dried soil for it to be at 60% to 80% of its water-holding capacity? In what situations would knowing the water-holding capacity of soil be useful?

Try this method on several types of soil and account for the differences in your results.

PERCOLATION RATE: SPEED OF INFILTRATION INTO SOIL

This exercise is one which can be performed in the field.

Materials: Cans of the same size with both ends removed

Procedure: Work each can into the ground about the same distance (about 2 cm).

Pour a measured amount of water into each can.

Measure the time required for all the water to enter the soil. Record it for each can and average the results.

Repeat this procedure in several types of soil--in a lawn, on a dirt road, in a garden, in a deciduous woods, and so on.

If worm burrows are available, do one measurement with the mouth of a burrow in the center of the can.

Discussion: Which soil types absorbed the water most rapidly? Why? State the advantages and disadvantages of fast infiltration of water into the soil.

Attempt this exercise using muddy water. Account for the difference in your results. How does this apply to percolation rates and erosion? How does the activity of worms help prevent flooding?

SEPARATION OF SOIL ACCORDING TO PARTICLE SIZE

Soils tend to separate on the basis of particle size. The following exercise is a simple method for demonstrating this principle.

Materials: Large mayonnaise jar

Sample of mixed soils from the same general area

Procedure: Fill the jar approximately 2/3 full of water.

Pour in the soil until the jar is approximately half-full of soil.

Agitate the jar vigorously for at least 30 seconds. Then let it stand until the soil settles.

Discussion: Describe and account for the appearance of the settled soil. In particular, why do particles having the same density but different sizes settle at different rates? Describe and account for the appearance of the water above the soil. How does the principle illustrated in this exercise apply to the natural formation of soils?

EFFECTS OF NUTRIENTS ON PLANT GROWTH

Plant growth is very dependent on the concentration of various minerals in the soil. Apparently, some minerals are essential to growth in height, whereas others are primarily involved in the tissue development of the plant.

In this exercise, you will add various minerals to the soil and observe their effects on the growth of selected plants.

Materials: Seedlings approximately 5 cm in height (for example, bean, corn, tomato)

15 flowerpots, 8 cm in diameter

a nitrogen compound, for example, sodium nitrate

a phosphorus compound, for example, sodium phosphate

a potassium compound, for example, potassium sulfate

a commercial plant nutrient mixture which contains nitrogen, phosphorus, potassium, and more

evaporating dishes

drying oven

Procedure: Fill each of the flowerpots to 2 cm from the top with the soil sample.

Add 1 gm of sodium nitrate to each of 3 of the flowerpots. Mix it into the soil well. Label these 3 pots.

Add 1 gm of sodium phosphate to each of 3 other flowerpots and mix well. Label these pots.

Add 1 gm of potassium sulfate to each of 3 other pots. Mix well and label.

Add 2 gm of commercial plant nutrient mixture to each of 3 more pots. Mix well and label.

Label the remaining 3 pots as controls.

Transplant 1 seedling into each of the 15 flowerpots.

Water the plants regularly. Observe and record their height each day for at least 3 weeks.

At the end of this time, open the flowerpots. Gently remove the soil from around the roots. Record the extent of their growth. Note also any apparent deficiencies in stem and leaf structure.

Cut each plant into small pieces and place it in a weighed evaporating dish. (Label each dish before weighing.) Place the dish and its contents in a drying oven at 100°C for 24 hours. Weigh the dish and contents. Calculate the mass of dry plant material.

Discussion: Make graphs of the height of each plant versus time over the 3-week period. How does root development compare to the final height? Which mineral or minerals appear to promote growth in height and development of roots, leaves, and other plant parts? You may have to do further experiments to answer these questions completely. For example, you may find it necessary to:

- a. Vary the concentration of sodium nitrate in a number of flowerpots to find out if there is an optimum concentration. Can too much sodium nitrate be added?
- b. Determine if optimum concentrations of sodium phosphate and potassium sulfate exist.

A LESSON PLAN FOR SOME INVESTIGATIONS FOR LAND USE PLANNING

Set the stage for this investigation by reviewing quickly what will take place in the allotted time. For example: "In the next 4 hours we will develop some skills and apply them to collecting and interpreting data about the soil environment and then apply that data to making some decisions about what the best uses of this land might be." You might want to read the behavioral objectives which appear at the end of this lesson plan and refer back to them as an evaluation of the session.

I. DESCRIBING SOIL

When you first meet the group, have them sit down to do Task A:

TASK A: (5 minutes) Work by yourself.

Describe in writing your own description of soil. Keep this description for your own reference at the end of the session.

II. OBSERVING AND RECORDING THINGS IN THE SOIL

Distribute Task B cards and have class work in groups of 3 or 4 and report findings in 15 minutes.

TASK B: (15 minutes) Work in small groups.

1. Predict what things you will find in the top few inches of this forest floor. List your predictions:

2. Stake out an area 2 or 3 feet square on the forest floor and sift through the top 3 inches of the soil, recording the evidences of plant and animals you observe.

Name or Description of Item in the Soil	Quantity	Possible Effect on Soil

3. The following three terms are used to describe organic matter at the top of the soil: litter, duff, humus. From your study above, complete the following chart:

Term and Definition	Describe the feel	List the identifiable parts of plants and animals you found
Litter (identifiable dead things on surface)		
Duff (partially decomposed organic matter-compacted)		
Humus (almost com- pletely decomposed nonidentifiable organic matter)		

Questions and discussion:

1. What did you find?
2. When would you expect to find more organisms? different organisms?
3. How do the organisms you found benefit the soil?

4. What are some reasons for odors in the soil?

III. DEVELOPING THE SKILLS TO COLLECT SOIL DATA

Move the group to the soil profile or soil pit.

Questions and discussion:

1. What can we see as we look at this cross section or profile of soil?
2. What are some things that would be important to find out about it? Accept all comments. The observable characteristics of color, texture, structure, temperature and the acidity or alkalinity (pH) of a soil are indications of some soil conditions important in land use planning.
3. We are going to collect and record some of this information. For the next few minutes, we will stay together as a group to develop skills in collecting soil data. After that, you will be working on your own.

Quickly (10 minutes) go over the following items about soil and collecting the data. This instructional session is extremely important. The participants will use the skills they develop in this session when they collect data for the micromonolith.

Soil components (not necessary to discuss in this order)

1. Soil layers (Horizons)

Mark where the soil changes color and general appearance. Many soils have 3 major layers or horizons; i.e., top soil, subsoil and parent material; Because soil formation has many variables, you may find more or less. Measure and record the depth of each major layer.

2. Color

Describe and record the color of each major layer. Have participants pick their own description of color.

3. Texture (How the soil feels)

Determine and record the texture of each major layer.

Texture is determined by feel. Push and rub moistened sample between thumb and forefinger. Spit on sample to moisten.

If it feels gritty.....sand

If it feels smooth and slick,

not very sticky.....silt

If it feels smooth, plastic,

very sticky.....clay

Note: Have samples of sand, silt, clay in cans. Have participants practice with these samples to find out what the textures feel like before determining textures of the soil profile under study.

4. Structure (How the soil is put together)

Determine the structure of each major layer. Carefully break apart a shovelful of soil from each layer and match its characteristics with one of the structure words on the work card. (Task C)

5. Determine and record the temperature of each layer. Plant's growth depends upon soil temperatures during the growing season. Find out growing season in the study area in advance.

6. pH (acidity or alkalinity)

Determine and record the pH of each major layer. Plants need many soil nutrients to grow well. The degree of pH also affects how plants grow.

Note to instructor: Demonstrate how to use pH kit in front of whole group. Use some foreign material like cigar ashes as a demonstration. Mention not to compact the sample in the porcelain dish. Use just enough pH reagent to saturate soil sample. Match color at the edge of the soil sample in porcelain dish with pH color chart.

IV. CONSTRUCTING A SOIL MICROMONOLITH

Explain that the skills just developed are going to be used to construct a soil micromonolith. Explain that a micromonolith is a small cross section of the soil profile. You can make one by just sketching the layers on the profile sketch, or putting samples of each layer in a baby food jar or other clear container. Distribute Task C cards. Notice there is a place to check or record the data collected and a place to sketch what the soil looks like.

TASK C: (20-30 minutes) Work in small groups or by yourself.

Using the skills you have just developed, and the available equipment, construct a soil micromonolith of this soil profile. Record your observations on the soil micromonolith lab sheet. You may want to make a micromonolith using the cards and jelly cups; if so, ask your instructor.

When finished with this task, report to the instructor to receive TASK D.

Air temperature 3 feet above soil surface	
Air temperature just above soil surface	

Sketch your soil profile, label the layers or horizons and record the data.

PROFILE SKETCH

DATA

Contents of material above soil: _____

_____, Depth _____ " to _____ ".

A. (Horizon): Depth _____ " to _____ ",

Color _____

Topsoil

Texture: Sand _____, Silt _____, Clay _____

Structure: Columns _____, Blocky _____,

Platey _____, Granules _____,

pH _____, Temp. _____, _____ °F,

Plant Roots Visible _____.

Record below the same information above for the rest of the layers.

Describe type of rock in the bedrock (if present)

V. ANALYZING YOUR SOIL DATA

TASK D: (20-30 minutes) Work in small groups or by yourself.

Using the soil data you collected and the following tables, answer the following questions:

Effect of Soil Depth on Plant Growth and Water Storage

Deep Soil (over 42")	Excellent water storage and plant growth
Mod. Deep Soil (20"-42")	Good water storage and plant growth
Shallow Soil (20" & under)	Poor water storage and plant growth

The potential of my soil for water storage and plant growth is:

excellent _____; good _____; poor _____

Why? _____

SOME RELATIONSHIP OF COLOR
TO SOIL CONDITIONS

Top soil Conditions	Dark (dark grey, brown to black)	Moderately dark (dk. brown-yell.br.)	Light (pale br.-yellow)
Amount of organic material	Most	Moderate	Low
Erosion factor	Low	Medium	High
Aeration	Excellent	Good	Low
Available Nitrogen	Excellent	Good	Low
Fertility	Excellent	Good	Low
Subsurface soil color (B horizon)			
			Condition
Dull Grey (if low rainfall soils)			Water-logged soils, poor aeration
Yellow, red-brown, black (if in forest soils)			Well-drained soils
Mottled grey (if in humid soils)			Somewhat poorly to poorly drained soils

- a. What can you say about the following, based on the color of the top soil, or A horizon?
- amount of organic material _____
- erosion factor _____
- fertility _____
- b. What can you say about the drainage in the B horizon, based on color?

Effect of texture on texture	Water holding capacity	Looseness of soil
Sand	Poor	Good
Silt	Good to excellent	Good
Clay	High (Plants can't use it in clay.)	Poor

My soil texture	Soil water-holding capacity	Looseness
Topsoil (A)		
Subsoil (B)		

EFFECTS OF STRUCTURE ON SOIL CONDITIONS

Type	Penetration of water	Drainage	Aeration
Columns	Good	Good vertical	Good
Blocky	Good	Moderate	Moderate
Granular	Good	Best	Best
Platey (like stack of plates)	Moderate	Moderate	Moderate

Using the structures you recorded, and the chart above, what can you say about the drainage properties of your soil for:

Topsoil (A) _____

Subsoil (B) _____

1	4.5	6.5	7	8.5	14
(1 to 4.5 is too acid for most plants)		(Most plants do best here)		(8.5 to 14 is too alkaline for most plants)	

Example of plants in pH range:

pH 4.0-5.0:	rhododendrons, camellias, azaleas, blueberries, fern, spruce
pH 5.0-6.0:	pinos, firs, holly, daphne, spruce, oaks, birch, willow, rhododendron
pH 6.0-7.0:	maple, mountain ash, pansy, firs, asters, peaches, carrots, lettuce, pines
pH 7.0-8.0:	beech, mock orange, asparagus, sagebrush

Using the pH ranges you recorded and the table above, complete the following chart:

Some plants that could grow here based on the pH and chart	Some plants actually observed growing here
_____	_____
_____	_____

Did your inferences about the soil pH-plant relationships check out:

Yes _____; No _____; Explain: _____

Is pH the only factor affecting where plants grow?

Yes _____; No _____

Explain: _____

Describe in a short paragraph how you would set up an experiment to collect data and construct your own soil pH-plant relationship chart.

SOIL TEMPERATURE

<u>Soil Temperature</u>	<u>Conditions during growing season</u>
Less than 40° F	No growth, soil bacteria and fungi not very active
40° F - 65° F	Some growth
65° F - 70° F	Fastest growth
70° F - 85° F	Some growth
Above 85° F	No growth

The growing season for my area is _____

What does the soil temperature chart tell you?

In the space below, convert the soil temperature table to a line graph. (5-10 minutes) Work by yourself.

Pages 32 and 33 missing from document prior to its being shipped
to EDRS for filming.

LAND USE CHART--Continued

Agriculture uses	Slope	Erosion hazard	Soil Depth	Drain- age	Tex- ture
Pasture, tim- ber growing, woodland, wildlife, no cultivation machinery	30-90	Very severe	Deep to Shallow	Well to poor	Sandy, silty, claying or rocky
Wildlife, recreation	all	None to extreme	Deep to Shallow	Ex- ces- sive to poor	Rock- land, river wash, sand dunes

The most limiting soil factor will determine the best agricultural use of the land.

Occupancy land uses by man

Man's varied uses of land has demanded criteria to determine proper management practices for living on the land. Examples in addition to agricultural uses include: prescriptions for aesthetic management, soil site indexes for growing timber, criteria for green belts, etc.

Some uses & factors af- fecting that use	Slight limitation	Moderate limitation	Severe limitation
Roads & Streets			
Slopes	0-12%	12-30%	Over 30%
Depth	Over 40"	20-40"	20"
Water- table	Over 20"	10-20"	10"
Building Sites			
Slopes	0-12%	12-30%	Over 20%
Depth	Over 40"	20-40"	20"
Water- table	Over 30"	20-30"	20"

Use and Factor Chart, Continued

Some uses & factors affecting that use	Slight limitation	Moderate limitation	Severe limitation
Septic Tank			
Filter Fields			
Slope	0-7%	7-12%	Over 12%
Depth	Over 6'	4-6'	4'
Water-table depth below trench	Over 4'	2-4'	2'
Picnic and Camp Areas			
Slope	0-7%	7-15%	Over 15%
Stones	0-20%	20-50%	Over 50%
Water-table during season of use	Over 30"	20-30"	20"

Distribute Task F cards.

TASK F: (20 minutes) Work in small groups.

Using the data from Task D, Task E, and the Land Use Chart, answer the following questions.

According to the agriculture and occupancy land use charts, this land could be used for:

Agriculture use:
(list & explain why)

Occupancy: (yes or no and with what limitations)

Roads and streets

Building sites

Septic tank filter fields

Picnic and camp areas

I feel the best uses of this land would be:
(justify your answer)

Questions and discussion:

1. How have you classified this land?
2. Based on your observations and the data you collected, do you feel this land is being properly used?
3. In your estimation, have man's activities affected the classification of this land?
4. Could man improve the capability of this area? How?
5. How could man reduce the capability of this area?

Distribute Task G cards.

TASK G: (10 minutes) Work by yourself.

Using the words from the data you collected and recorded on the soil micromonolith card, write a description of the soil in your soil study. Compare this description with the one you wrote at the beginning of the session.

Questions and discussion:

1. What are some factors that contribute to soil formation?
2. What evidences of geological changes have you noticed in this area?
3. What other factors might affect uses of the land? (climate, growing season, needs of community, economic, past history of uses, etc.)

VII. COMMUNICATING FEELINGS, AWARENESS, AND VALUES ABOUT SOIL

Distribute Task H cards.

TASK H: (10 minutes)

Describe what you can do to improve the use of the soil: in your backyard, in your community.

Questions and discussion:

Ask for individual descriptions and have group discuss. Relate back to the responses given to questions after TASK F.

What types of community action can we take to identify and help solve soil and land management problems in our community? How do these relate to zoning laws, planning commissions, local and state political discussion-making?

Take these data or processes of collecting data and identify a local land use problem and develop a simulation game similar to the Center Place game. (See Lesson Plan Outline for an Environmental Land Use Simulation Game.)

Summary Questions

1. What did we find out about the environment in our study today?
2. How are soil characteristics important in environmental management?
3. How can we summarize our discussions and investigations?
4. What processes and methods did we use in our investigation today?
5. Let's review the behavioral outcomes for this session to see if we achieved our objectives. Read list and have group comment.

Distribute Task I cards.

TASK I:

Describe in writing how you feel about our session today. (Evaluation)

Behavioral Outcomes in Knowledge

As a result of this session, you should be able to:

1. Describe three ways in which the living organisms in the top part of the soil affect the soil.
2. Construct a soil micromonolith of an assigned soil profile, determine and record texture, structure, pH, temperature, and color of each layer.
3. Write a description of a soil you studied, using the words you recorded about that soil on your micromonolith.
4. Demonstrate the ability to determine the best uses of the land in this area, using the data from your soil micromonolith and the land capability charts.
5. Describe three things that man does to determine the proper management of the soil resource.

Behavioral Outcomes in Feelings, Awareness, Values, and Action

As a result of this session, you should be able to:

1. Describe how you feel about man's effect on this soil environment.
2. Describe how you feel about man's effect on the soil environment where you live.
3. Describe what you can do to improve the use of the soil:
 - in your backyard:
 - in your community:

Equipment needed: (for a class of 30 people)

- | | |
|---------------------------------------|---------------|
| 6 La Motte soil pH kits | 3 staplers |
| 30 micromonolith cards | 1 box staples |
| 6 tape measures | 2 shovels |
| 30 sets of lab sheets | 3 yardsticks |
| 3 sticks (50" or 100" long) | |
| labels to differentiate soil horizons | |
| 100 jelly cups and lids | |
| 3 soil thermometers | |
| 2 #10 cans of water | |
| 30 hand lenses | |
| 3 baby food jars, 1/2-full of water | |

A LESSON PLAN FOR A LAND USE SIMULATION GAME

Set the stage for this investigation by reviewing quickly what will take place in the allotted time. For example: "During this investigation we are going to participate in a simulation game concerning land use in a hypothetical community, analyze what we have done, and present some ideas which will enable you to develop your own simulation game based on local environmental issues or concerns." The techniques used in simulation games combine elements of simulations, games, and role-playing. Students assume the roles of decision-makers in a simulated environment and compete for certain objectives according to specified procedures and rules. (Note to teacher: Use as much of the information about simulation games included below as needed. This will depend on how familiar participants are with this type of activity.)

Some Information About Simulation Games (Use as needed to set stage.)

Simulations are operating models of real life situations. They may be about physical or social situations.

Most simulations for classroom use involve role-playing--the roles being acted out to correspond to the functioning of some real process or system.

Most simulations for classroom use involve gaming. A game is defined as something enjoyable--however serious it might be--involving competition for specified objectives and observing rules.

Some simulation games are based on environmental issues. What are some benefits of using simulation games as an instructional technique for investigating environmental problems?

They're fun.

They get people involved.

They are a logistically easy way of helping to prepare people for becoming involved with solving environmental problems.

People analyze cause-and-effect relationships of environmental issues.

People are put in role-playing situations where they have to suggest alternative solutions to environmental concerns.

People are forced to evaluate the consequence of decisions in discussion or on paper before these decisions are carried out in reality.

People interact with each other in the decision-making process. So . . . simulation games not only:

develop understandings about problems in the environment and
develop awareness and concern about those problems,

But they help people develop skills they need for citizen action and involvement in environmental management.

I. INFERRING, RECORDING AND CLASSIFYING POSSIBLE USES OF LAND

Discussion:

- A. Distribute TASK A, Centerplace City Land Use Problem.
- B. The problem to be decided is what are some possible uses for the one-square mile (640 acres) of county farmland, four miles north-east of the city. It is now available for the city's use.

TASK A: (10 minutes) Work by yourself.

Read the background information for Centerplace City, and then list some possible uses of the vacant farmland.

"One square mile of unused county farmland, four miles northeast of the city is now available for the city's use."

Background Information Sheet: Centerplace City

The population is 250,000 and rapidly increasing.

The city's boundaries are being extended, but the suburban fringe is expanding even more rapidly.

The rapid population growth is accompanied by demands for more housing, more jobs, additional city services, and recreational areas.

The power for industrial uses, adequate public transportation, and a skilled labor force are available.

The city is located near forests, which are to the north.

The land to the east is devoted mainly to farming. The Pipe River is unpolluted and is the source of irrigation water as well as the municipal water supply.

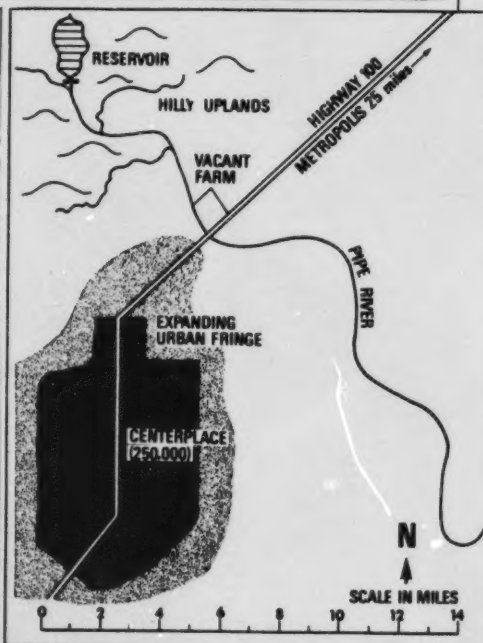
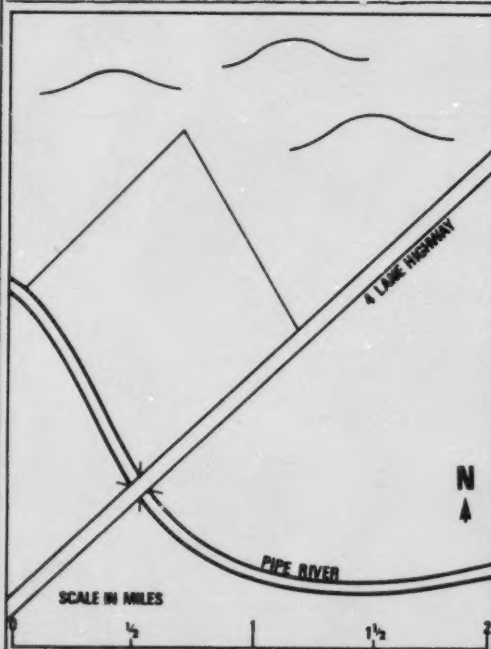
The river is too small for freight transportation, but logs could be floated on it.

The gravel bed of the river is appropriate raw material for concrete manufacture.

The present sewage treatment plant and garbage disposal area are at maximum capacity. The citizens of Centerplace are concerned about the maintenance of a scenic regional environment.

The County Board of Control is the authority for land zoning, and many citizens' groups are developing to influence zoning decisions.

List possible uses of the land below:



Questions and discussion:

Note: When most people have started to write down uses on Task A, go ahead with question #1.

1. What are some possible uses for the undeveloped land? As people respond, write all comments on board, just as they say them. Don't paraphrase for them unless they are too wordy, in which case, ask. "How shall I write that on the chart?" If they give major categories right away, like Recreation, or Industry, say, "Can you give me an example of that?" Number the items as you go along--to simplify identification later. When you get 15 or 20 items, STOP.
2. "Which of these uses are similar?" Designate similar uses by letters--A, for all of one type; B, the next, etc. When most are designated with a letter, or the group seems to run out of thoughts, STOP. It's okay to change the groupings if the students change their minds along the way in #2 above.
3. What label could we give to all the items in A? "What label could we give to Group B?", etc., e.g. Recreation, Industrial, Utilities, Housing, Commercial. It's okay if they suggest more than one label for a Group; write them both down.

II. DEVELOPING AND GIVING PRESENTATIONS

- A. Divide the class or group into the number of categories decided on in #3. There shouldn't be more than 6-10 in each group. Assign each group to one of the use categories.
- B. Each group is to represent the special user group assigned.
- C. Pass out TASK B and inform the students they have 10 minutes to list and analyze possible uses for the vacant land in the assigned category. They may consider those listed on the board in their category plus any other possible uses they can think of for the category.

TASK B: (10 minutes) Group # _____

Assigned Category of Land Use _____

Your task is to analyze and list possible consequences of different land uses within your assigned land use category.

Use	Advantages to land/people	Disadvantages to land/people

(At end of 10 minutes go on.)

Discussion:

Tell group: Now go on to TASK C. You have 20 minutes to plan a strategy and develop a 3-minute presentation to be made to the County Board of Commissioners.

- This presentation will be a proposal for developing the undeveloped farmland.
- You must have a visual display such as a land use map drawing as a part of your presentation.
- More than one person in your group must help in making the presentation.

Distribute Task C cards.

TASK C: (20 minutes)

Develop a strategy and method to present your plan of development to the County Board of Commissioners or appropriate local authorities.

Note: If possible, have a staff person assigned to each group to make written observations about how the group was able to work together to solve the problem.

1. Ten minutes into Task C, have each group select one of its members to meet together as the County Board of Commissioners. Take the Board into another room, and tell them they will be responsible for hearing the presentations and deciding upon the best one. Their job in the next 10 minutes is to:
 - a. Develop the criteria they will use in evaluating the proposals.
 - b. Develop some kind of matrix they can each use while the presentations are being given to record their evaluations.
 - c. Elect a chairman to preside during group presentations.

CRITERIA

Presentation			

2. Twelve minutes after groups start planning TASK C, remind them they have 8 minutes left to have their verbal and visual presentation ready. Let groups have 5 more minutes to finish if needed.
3. Have Board of County Commissioners enter room and sit up front. Appoint a timekeeper to cut all presentations off at 3 minutes (give 2-minute warning). Announce: "Because of time, there will be no rebuttals or discussion." The Board may want to ask questions or have rebuttal time after all presentations. However, allow only 5-10 minutes for this part so it won't get out of hand.

4. After 3 is finished, the Board retires for 5-10 minutes to select the best proposal.
5. While Board is meeting, each small group is to develop a list of criteria they think should be used in choosing between the plans submitted.
6. County Board of Commissioners announces their decision and gives reasons why.
7. County Board of Commissioners reads their criteria aloud.

Questions and discussion:

1. Did new leadership emerge during this session? What factors enabled this to happen? Call of staff observers if used.
2. Did your group work as a team? What did your group do to insure participation by all members of group?
3. What happened in the groups? How did you feel as a person? What about the criteria used? How did each observer see the interaction in the groups?
4. What additional data would you have liked to have had for your groups? List on board, e.g.: topography, vegetation, economy of area, railroad, shopping center, adjacent land, climate, soil survey, historical information, flood plain, wildlife, interest of board of control, money available, educational needs, regulations by State, existing zoning, political climate, population information (age needs, race, jobs). What elements in the community discussion might support each interest?

Note: This is one of the most important parts of the activity because it emphasizes that we need a variety of information and data before we can intelligently make a land management or environmental decision to best meet the needs of people and their environment. This question list has all the elements that need to be considered in studying a local environmental issue or concern. It also includes elements of all the curriculum subject areas (social studies, science, language, arts, etc.).

III. ANALYZING CHARACTERISTICS OF SIMULATION

Questions and discussion:

1. One group of people working with simulation games has identified at least three basic characteristics of most simulation games:
 - a. There is a problem to be solved.
 - b. The factors affecting the decisions are identifiable.
 - c. Groups or individuals with different interests who will be affected by the decision can be identified.
2. Let's see if the game we just played has these components.
 - a. What was the clearly defined problem in the Land Use Alternatives Simulation?
 - b. What factors influenced the decision in the Land Use Alternatives Simulation?
 - c. We assigned groups to fit each role in the Land Use Alternatives Simulation, but we all helped develop those roles from the items we listed on the chart. What group or individual roles were identified? How were they identified?

IV. DEVELOPING YOUR OWN SIMULATION GAME (OPTIONAL)

Discussion:

The most exciting simulation games are those people develop themselves, based on local environmental issues in their community, State or region.

Can you think of some current environmental issues in your community around which you could develop a game? Call for responses.

For the next 30 minutes, you will work with one or two other people, developing the format for a simulation game based on a local land use issue described in a news article. (Have copies of current newspaper article available if students want to use them.) Remember that three basic characteristics of a Simulation Game are:

1. There is a problem to be solved;
2. The factors affecting the decision are identifiable; and
3. Groups and individuals with different interests who will be affected by the decision can be identified.

At the end of that time, we would like to hear from several of you about what you have developed.

Pass out TASK D cards.

TASK D: (30 minutes)

DEVELOPING A SIMULATION GAME

Work with 1 or 2 other people.

Using a newspaper article about a local environmental land use problem, develop the format of a simulation game, considering the following items:

Identify the problem or issue to be decided upon.

Identify the choices available to the decision-makers.

Identify the factors having an influence on the decision.

Identify individual or group roles.

Identify the factors (for or against) assigned to each role.

Establish conditions for the players (i.e., resources, voting procedures, bargaining money, etc.).

Develop specific goals or objectives for the players.

Include limits or rules for what is permissible behavior (time factor, trading, No. points, money allocations, etc.).

Ask for reports from those who want to share.

Questions and discussion:

1. How can you use the techniques in this session in your job situation? Classroom?
2. How could a game like this develop decision-making skills in environmental management?
3. Have any of you used simulation games? Tell us about your experiences.
4. How can we take this process and use it to involve the public in social and political decision-making action projects in the community?
5. How can we summarize the use of simulation games in studies about the environment?
6. Which of the behavioral outcomes did we accomplish in this discussion? (Read and discuss.)

If the group is interested in further analysis of the elements of simulation, see the following:

1. One important characteristic of a simulation is a clearly defined problem, including the choices available to the decision makers.
 - a. How would you formulate the problem or issue you were asked to decide upon?
 - b. Did the developer of this simulation simplify the choices?
 - c. If so, how did he do it?
2. A second major characteristic of educational simulation is the factors having an influence on the decision. Several objectives and subjective factors to be considered in making a decision need to be clearly identified. These factors indicate the data that are relevant to each of the possible choices.
 - a. What factors were selected as influences on the decision?
 - b. Which of these factors would you classify as objective?
 - c. Which of these factors would you classify as subjective?

3. A third characteristic of educational simulations is the use of identifiable group or individual roles to present information about the problem and many of the variables in the situation. Also a role can be planned to incorporate a limited number of factors that influence the choice to be made.
 - a. What roles were identified?
 - b. What variables did these roles contribute to the decisions?
 - c. What additional roles could have been identified?

Distribute Task E cards.

TASK E:

Describe how you feel about our session today.

(Have commercial games such as Dirty Water, Ecology, Coca Cola Game, Pollution, etc., on display if possible.)

Behavioral Outcomes in Knowledge.

As a result of this session you should be able to:

1. Identify and describe three component parts of simulation games.
2. Construct your own simulation game based on a current environmental issue.
3. Name and describe at least 10 important types of data needed before making a land management decision.
4. Identify cause and effect relationships that exist in environmental management.
5. Describe alternative solutions to solving specific problems.

Behavioral Outcomes in Feelings, Awareness, Values, and Action

As a result of this session you should be able to:

1. Describe how the information in #3 above affects your life, community, and the management of the environment.
2. Outline a plan of action to affect a solution or partial solution through the social and political decision-making process about the environmental issue you used in developing your own simulation.

Equipment needed:

blackboard or easel
chalk or magic markers
newsprint or butcher paper (enough for each group to make visual display)
magic markers (4 colors for each group to make visual display)
masking tape
task cards
commercial games on display

The Centerplace City problem has been adapted with permission from the May 1970 Journal of Geography from the article "A Land Use Alternatives Model for Upper Elementary Environmental Education" by Dennis Asmussen and Richard Cole, University of Washington.

References: There are many publications on simulation games. Two that may be of value to you are:

1. Games in Geography, Rex Walford, Longman group limited, London paperback.
2. Simulation Games for the Social Studies Classroom--from The Foreign Policy Association, 345 East 46th St., New York, NY 10017. Library of Congress #68-24538.

RESOURCES

- I. People
 - A. There are a number of people in your community who can help you in your unit on soils. One important source is the senior citizens in your community. They can not only provide interesting history of the soil, but many are quite active and accomplished gardeners and would be eager to work with children in the outdoor classroom.
 - B. Local farmers and ranchers can also be used as classroom speakers and as a source of land for field trips.
- II. Agencies
 - A. The first agency to contact when planning a unit on soils is the Soil Conservation Service. There are 88 offices of the S.C.S. throughout the state; just look in the yellow pages under United States Government offices. The District Conservationists from these offices throughout the state have been quite active in assisting schools in all phases of Conservation Education.
- III. Other Resources
 - A. Books
 - 1. Andrews, William A. A Guide to the Study of Soil Ecology, Prentice Hall, 1973.
 - 2. Corbett, J.R. The Living Soil, Martin-dale Press, 1969.
 - 3. Berger, Kermit C. Sun, Soil, and Survival, University of Oklahoma Press, 1973.
 - 4. Buckman, H.O. and N.C. Brady. The Nature and Properties of Soils, MacMillan, 1969.
 - B. Films

Several films are available from the Soil Conservation Service. Check with your District office.

 - 1. ERTS - Earth Resources Technology Satellite, 1973. Color, 27 minutes; order from:

NASA - L.B. Johnson Space
Center
Public Affairs Office
Houston, TX 77058
 - 2. Land for People, Land for Bears, 1976. Color, 27 minutes; order from:

NASA - L.B. Johnson Space
Center
Public Affairs Office
Houston, TX 77058

CHAPTER II - WATER

Water, water, everywhere
Nor any drop to drink.

--S.T. Coleridge,
The Rime of the Ancient Mariner

The next glass of water you drink will contain some of the same water that was in the Red Sea when Moses, according to biblical tradition, parted the waters and led his people to freedom. This mathematical oddity is the result of the tremendous number and extremely small size of water molecules and points to the general acceptance of water as being a renewable resource.

Early man judged the quality of water with his senses. Unpleasant sights and odors might deter the use of ground or surface water as a source. The consumer received untreated or raw water. The natural processes of water purification has in the distant past taken care of man's needs, but since 1850, the world's population has almost tripled since 1900. Commerce and industry have likewise expanded creating substantial increases in per capita use of water. People are using water faster than natural processes can refine it.

Man can exist on a gallon or so of water a day for drinking, cooking, and washing although he seldom does or has had to. In Medieval times he probably used no

more than three to five gallons per day. In the nineteenth century, particularly in Western nations, he was using 95 gallons per day. At present in the United States, we use about 1,500 gallons per capita/day for our needs and comforts such as recreations, cooling, food production, and industry.

Obtaining the desired quantity and quality of water is no easy task. Our water supply comes to us in the form of precipitation and currently man can do little to systematically alter the earth's complex water cycle. The amount of water on the earth is finite and limited, therefore conservation of water is an absolute necessity if we are to maintain a high quality of life in this generation and in those to come!

CONSERVATION AND THE WATER CYCLE

HOW HYDROLOGIC PROCESSES AFFECT THE EARTH AND ITS INHABITANTS



SUN'S RAYS
(ENERGY)

RAIN CLOUDS

CLOUD FORMATION
(CONDENSATION)

ADVANCING
AIR MASS

WATER VAPOR

P R E C I P I T A T I O N

RAIN, SLEET, HAIL, SNOW

E V A P O R A T I O N F R O M

PRECIPITATION

JET PLANES,
TRACTORS,

AUTOS, FURNACES,
FIRES (COMBUSTION)

RIVERS
STREAMS

PONDS
LAKES
SWAMPS
MARSHES

ANIMALS
(RESPIRATION)

SOIL

PLANTS
(TRANSPIRATION)
AND
(RESPIRATION)

OCEAN



SURFACE
RUNOFF

TO STREAMS

TO LAKES

TO RIVERS

TO OCEAN

GROUND SURFACE

INFILTRATION

WATER TABLE

TOPSOIL

ZONE OF
PERCOLATION

PARENT
MATERIAL

SPRING

IMPERVIOUS MATERIAL

ZONE OF SATURATION
(GROUND WATER)

IMPERVIOUS MATERIAL

C6
BEDROCK

DEEP PERCOLATION

THE HYDROLOGIC CYCLE

The hydrologic cycle or water cycle (Fig. 1) has no particular beginning or end and is occurring continuously on all parts of the earth. Water cycling through the earth's ecosphere is a unifying factor in maintaining all of the earth's life forms including man. Water in the human body, for example, is completely replaced several times each year.

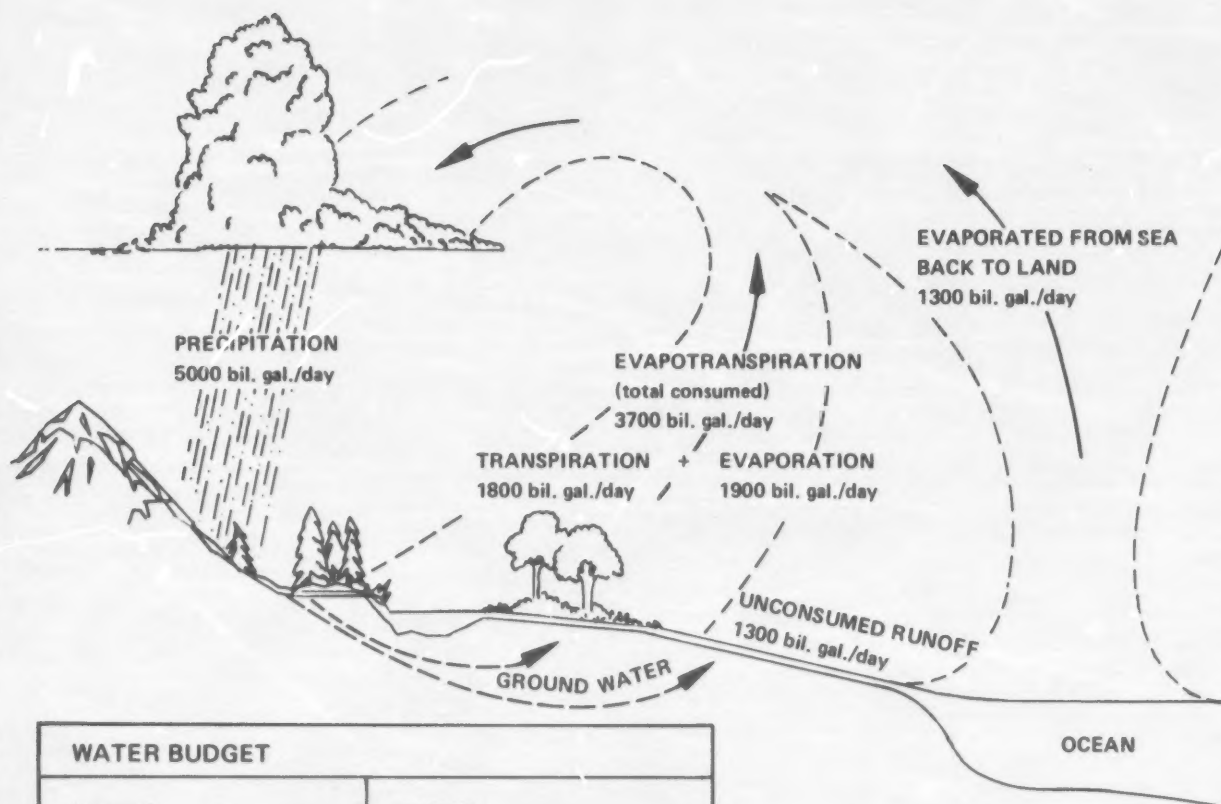
Water comes to us as precipitation, i.e., rain, sleet, hail, or snow, with the process ultimately being governed by the sun. Solar energy evaporates water from oceans, lakes, rivers, and soil. Water given off by plants through transpiration, animals through respiration, and machines through combustion contribute to the total water vapor. Most of the vapor in the atmosphere is evaporated from the salt water oceans.

Air masses carry water vapor across the land. Upon being cooled, the water vapor condenses and falls as precipitation. Some precipitation evaporates while falling and is returned to the atmosphere. Most of the water reaching the earth soaks into the soil where it is available to sustain plant life. That which percolates through the soil past plant roots continues downward filling the spaces between soil particles and within porous rock. The upper surface of this stored ground water is called the water table. Generally, the water table moves higher or lower depending on annual rainfall.

Water not soaking into the soil runs to the sea by way of streams and rivers. Misuse and poor management of the soil decreases the amount of water that soaks into the soil and increases the amount that runs off over the surface. Runoff on bare lands leads to erosion. Grass, trees, and other plants hold the soil in place and slow the runoff allowing more water to soak into the soil. Runoff on its way to the sea is intercepted and stored for industrial, recreational, or household use and is also diverted for the purpose of irrigation.

Most of the surface water in the United States is already committed to maintaining our standard of living and is rapidly reaching the maximum potential to support us at current standards. Subtracting what we are not using from the total available water supply gives an estimate of water use in the United States. Estimating thirty inches of annual rainfall on the surface area of the continental United States produces 5/000 billion gallons/day. Figure 2 represents the total water available for our use. Only about 26 per cent of this 5/000 billion gallons/day makes its way to the sea. The remaining 74 per cent is returned to the atmosphere through evaporation and transpiration by plants. The 26 per cent, or approximately 8 inches of our annual rainfall is what is available for stream flow and replenishment of ground water sources. The maximum theoretically available

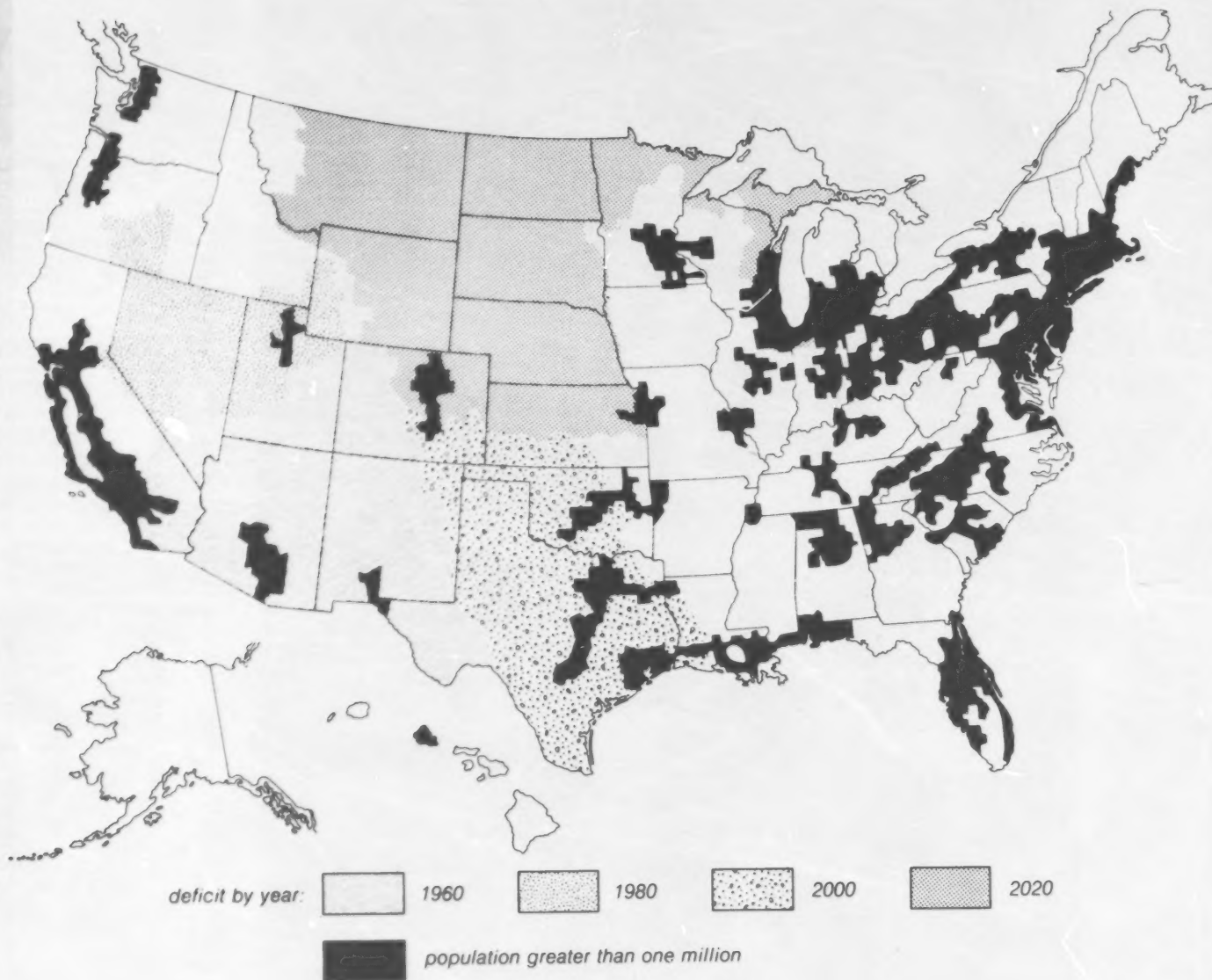
renewable water is about 3,500 to 6,500 gallons per person per day.



WATER BUDGET	
INCOME	OUTGO
from precipitation 5000 bg/d	Transpired 1800 bg/d Evaporated 1900 bg/d Total consumed 3700 bg/d Unconsumed runoff 1300 bg/d
TOTAL INCOME 5000 bg/d	TOTAL OUTGO 5000 bg/d

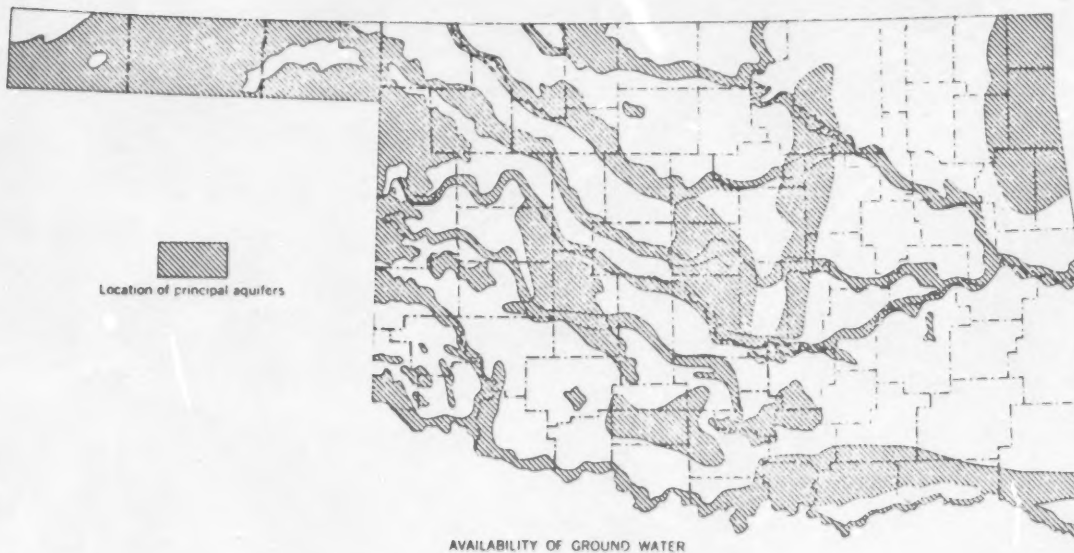
During the past fifty years there has been a 350 per cent increase in per capita use of water. A vast quantity of water is necessary to raise our food, run our industries, and serve municipal and personal "needs". On the average, each American citizen is supported by at least 1,800 gallons of water per person each day! Considering the maximum available water (3,500 to 6,500 gallons per person per day), it looks like we could, by using almost every drop of rain that fall, more than double our population and maintain our current standard of living. This is, of course, impossible because there would be no surface water to generate power, carry away the nation's sewage, float a boat, or raise a fish. We are still continuing to increase our per capita net use of water. Because of the increased usage, it is projected that by the year 2000, we will be very near the upper limits of the usable water supply.

Our country has two distinct water problems. The Southwest has a natural water shortage. In selected areas of the East Coast, pollution creates a lack of usable water. In some areas of Southern California, Utah, Arizona, Colorado, Oklahoma, and Texas, both problems will occur.



14-9 Present and future water deficit regions compared with megapolitan regions, having high water and air pollution. (Commission on Population Growth and the American Future 1972, pp. 33-46.)

Ground water--water trapped in underground aquifers--is a source found almost everywhere. It supplies us with 20 per cent of our fresh water. Better than 95 per cent of rural Americans use ground water for domestic use. Upper level aquifers are recharged naturally and may be considered as renewable; however, deep aquifers often take tens or hundreds of thousands of years to replenish. In areas of the Southwest (Tucson, Phoenix, Albuquerque, and Denver), water tables have been dropping sharply as water is pumped from the ground for agricultural and urban use.



There is evidence that in many areas of the country, the annual draft from the ground-water reservoir exceeds the annual recharge. For example, that area of the country from South Dakota to Central Texas draws most of its underground water from one aquifer, the Ogallala formation. The water is presently being pumped out at an estimated rate of 10 million acre-feet annually; however, the annual recharge rate is estimated to be only about .27 million acre-feet.

In recent years, laws have been passed to solve pollution problems in rivers, lakes, and oceans. Relatively little has been done to protect ground water sources. Seepage from garbage dumps, mining, septic tanks, feedlots, radioactive waste, and agricultural pesticides and herbicides is finding its way into underground aquifers. Cleaning up a stream can be accomplished in a short time--a lake much longer, but underground water sources take even longer to be renewed by natural processes.

WATER QUALITY AND QUANTITY

Many factors influence the availability and kind of water we receive. For example, annual rainfall is determined by interactions between different levels of (1) solar energy falling on the earth, (2) air transparency, (3) solar reflection from the earth's surface, and (4) the average time water resides in the atmosphere. For convenience, these factors are grouped into three categories--physical, chemical, and biological. Physical, chemical, and biological factors all interact to influence the quality and quantity of water.

A. PHYSICAL FACTORS

1. Temperature

The distribution and circulation of heat around the earth is to a large extent the result of the evaporation and condensation of water. Water has the ability to store great amounts of heat primarily because the heat required to evaporate a given amount of water is very high. If you take one gram (20 drops) of water, by definition it requires one calorie to raise its temperature one degree Celcius. Thus one calorie added to one gram of water at 10°C will raise its temperature to 11°C . This holds true for liquid water between the temperature of 0°C and 100°C . One gram of liquid water at 0°C plus 100 calories raises the temperature to 100°C . However, if we take one gram of liquid water at 100°C (boiling point), it now requires 540 calories to convert

this liquid gram of water to vapor. The 540 calories are stored in the vapor, yet its temperature is still 100° C. To return this vapor back to a liquid, we would be required to remove 540 calories. For a more practical example, consider a small summer thunderstorm that drops a half inch of water over one square mile. This is more than a million cubic feet of water weighing more than 36,000 tons. To evaporate this water from the ocean takes nearly 20 trillion calories (1.8×10^{13}) of the sun's energy. When this vapor condenses to form the storm clouds and raindrops, the 20 trillion calories are released and warm the surrounding air. This cycle of evaporation and condensation is a massive and efficient mechanism for distribution of heat from the warm equatorial regions of the earth to higher latitudes.

Most of us have had personal experience with the idea that cold water "sinks". When diving or swimming in a pond or lake, the cool layer beneath the surface has often provided us with a shock. As water is cooled, its particles are believed to move closer together. Therefore, any fixed amount of water will occupy less space. It follows that this water will weigh more (greater mass) for each unit of its volume. Cooler water when surrounded by warmer less dense water will sink. Knowing that colder water sinks raises the question, "If cold water sinks, why doesn't a pond freeze from the bottom up?"

The answer to this question lies in an unusual property of water. Most substances are denser when in solid form. For example, when Carbon Tetrachloride is cooled, the colder liquid moves to lower levels and becomes solid (freezes) at the bottom. Water is an exception to the rule. The greatest density (mass/unit volume) of liquid water occurs at about 4 degrees celsius* (4 degrees above freezing). Liquid water at temperatures between 0 degrees celsius and 4 degrees celsius is actually less dense than water at a temperature between 4 degrees celsius and 100 degrees celsius and thus rises to the surface where the final change of state to ice takes place. The surface layer of ice insulates the water below and shelters aquatic life from extreme cold. If water between 4 degrees celsius and 0 degrees celsius continued to increase in density, it would move to the bottom of a pond or lake. If an increase in density continued as solid ice was formed, the ice would remain on the bottom. Then lakes, rivers, and ponds would freeze from the bottom up. This does not happen due to the decrease in density between 4 degrees celsius and 0 degrees celsius.

Consider the kinds of aquatic organisms that might have evolved if it were not for this unusual property of water. What effects would freezing from the bottom up have on advanced forms of aquatic life?

*SI Metric Units use °C as degrees celsius replacing the use of °centigrade.

Temperature affects the density of water and causes layers of water to develop in still ponds and deep lakes. Cool water at lower levels with a warmer layer on top is referred to as thermal stratification. There is a mixing of water from these layers or strata with temperature changes occurring with the seasons of the year. This turnover or mixing of the stratified water is important in determining the quality of water and survival of aquatic organisms.

Wind is the major force which turns over a pond or lake. Wind and the resulting wave action tends to pile up water on the leeward side. This action, coupled with upper and lower strata temperature changes, may cause the relative positions of the strata to change.

In a deep lake or one protected from the wind, it is possible that turnover may not take place. The lower cooler layers of water remain trapped under warmer water. This trapped water does not come in contact with the atmosphere. Dead plant and animal life settle in this trapped layer and during the process of decay, the available oxygen in the water is depleted. Eventually only anaerobic microscopic organisms can survive in the lower depths. If sulphur is present in the water, as is the case in Oklahoma's Lake of the Arbuckles (located near Sulphur, Oklahoma), H_2SO_4 (sulfuric acid) and H_2S (hydrogen sulfide) are produced. The upper strata may contain water of high quality, but in effect, the lower

portion of the water is "dead"! The odor of rotten eggs and the black residue lining the stream below the dam of such a lake attest to the presence of hydrogen sulfide.

Temperature of the environment is an important regulator of life processes. It is one of the important physical factors that determines the distribution of organisms. Water temperature changes take place gradually and fluctuate within a very narrow range. Aquatic organisms are mostly cold-blooded and are adapted to a narrow range of temperature variations. Sudden or extreme changes in water temperature can be fatal.

2. Light Penetration

A beam of light falling on a water surface at an angle is in part reflected and in part penetrates the water. The amount reflected depends on the angle the rays make with the water's surface. The greater the angle, the less radiation reflected. Penetration would be greatest with the sun directly overhead and the rays contacting the water at a 90° angle. More light rays penetrate water during midday as opposed to morning or afternoon. Likewise, penetration would be greater as you move from either the North or South Pole toward the equator.

Organic or inorganic particles suspended in water also determine the depth of light penetration. Small

living organisms (phytoplankton and zooplankton) and sand or silt particles restrict the sun's rays from reaching great depths and affects the clarity of the water. When light cannot penetrate the water, photosynthesis by aquatic plants terminates.

An indication of the depth of visibility can be obtained with the use of a Secchi disc. A white plate 20 to 25 cm. in diameter is lowered on a calibrated line until it disappears. The depths indicated by the calibrated line is the depth of visibility and provides a measure of the water's transparency.

3. Color

Often the most striking aspect of water is its color. Shades range from deep blue of a lake through the emerald green of a clear stream to the browns of a shallow pond.

Color is influenced by a number of factors. Dissolved substances, particles in suspension, the color of the sky and surrounding rocks or forest, and in the case of shallow water, the color of the bottom. A deep, pure body of water appears almost black when viewed from directly overhead. Brown humus particles carried into the water from the soil bring about green, yellow, and brown colored water as do the various phytoplankton which have green, yellow, and sometimes red pigments.

4. Transportation of Materials

Running water is the most powerful agent acting to shape the earth's surface. It acts in two ways. Water carries material ranging in size from boulders, sand, and silt (sediments which settle out in standing water), through colloidal particles (tiny suspended particles which do not settle out) to dissolved ions (dissolved material such as salt). In general, these materials are carried from higher to lower elevations. In addition, water by its own action creates much of the debris it carries.

Small particles of soil, such as sand and silt, enter streams from a variety of sources. Water running off the surface of areas that have been cleared of vegetation may carry large amounts of material into streams and lakes. The size of the particles and the distance they are carried is determined by the velocity of the moving water. The greatest cause of water pollution results from runoff carrying material like silt from areas disturbed by fire, farming, over-grazing, industry, and building of homes, roads, and other forms of construction.

5. Osmotic Balance

A soluble substance such as sugar or salt placed in water gradually dissolves and disperses (diffuses) throughout the liquid and until evenly distributed. Dissolved substances always tend to diffuse from higher

toward lower concentrations until equilibrium is reached. It is also true that where the sugar or salt content is high that water is present in lower concentrations than in pure water, and water will likewise diffuse from higher to lower concentrations. Both the dissolved material and the solvent (water) tend to diffuse in this fashion. If the water and dissolved material are separated by a semi permeable membrane (one which allows water to pass through but not the salts or other dissolved material) such as a cell wall, osmotic pressure results. For example, the membrane of the red blood cell is permeable to water but seemingly impermeable to salts. If it is placed in a solution of about 160 millimolar NaCl (salt concentration about that of blood plasma) the cell retains its shape and size, but if placed in a more dilute solution, water enters and the cell swells. Water moving from higher concentration has passed thru the membrane. If the cell is placed in an even more dilute solution, it may swell to the point of bursting. Now if the cell is immersed in a solution with a higher concentration of salts than its own cytoplasm, water leaves the cell and it shrinks. Cells of land plants located along coastal areas if exposed to sea water experience a water loss from the cytoplasm (exosmosis) and they may be killed. This phenomena is referred to as plasmolysis.

B. CHEMICAL FACTORS

1. pH

When materials dissolve in water, the bond that holds the materials' smallest unit (molecule) together often breaks. The resulting charged particles are called ions. For example, salt (NaCl) when dissolved in water, forms Na^+ ions and Cl^- ions. Water itself ionizes; that is, a molecule of water (H_2O or HOH) breaks down into a hydrogen ion (H^+) and a hydroxide ion (OH^-). In pure water, only about one of every ten million water molecules ionizes. Yet this seemingly tiny amount is very important to life.

Some chemicals dissolved in water break down and release hydrogen (H^+) ions while others release only hydroxide (OH^-) ions. When water contains more H^+ ions than OH^- ions, it is acidic. If more OH^- ions than H^+ ions are present, it is considered basic or alkaline. pH expresses the concentration of hydrogen ions (H^+) in a solution on a scale that runs from 0 to 14. On this scale, 7 is neutral meaning there are as many H^+ ions as there are OH^- ions. Below 7 is acidic (more H^+ ions) and above 7 is basic or alkaline (more OH^- ions). There is a tenfold difference between each unit. Thus, pH6 is ten times more acid than pH7, pH5 is 100 times more acid than pH7, etc.

The pH of natural waters is usually between 5 and 9 depending on the activities of the living things in and

around the water and the nature of the materials carried in the water.

As a lake or pond matures, the pH generally changes. Usually basic when young, it becomes more acid as it gets older. With age, organic materials build up and as these materials decay, they release carbon dioxide (CO_2) gas. The CO_2 reacts with water to form H^+ ions which cause acidity.

Leaching of salts from soil and rock tend to make water basic. Sewage, chemical waste, and other material resulting from man's activity can greatly alter the pH of water. For example, there is a growing body of evidence that shows increases in the acidity of rainfall. This trend toward "acid rain" appears most dramatically where great quantities of sulphur and nitrogen oxides are found in the atmosphere. Combustion of fossil fuels such as coal, oil, gasoline, and natural gas releases sulphur and nitrogen oxides which combine with water to form strong sulphuric and nitric acids. Normally, rainwater is about pH 5.7, slightly acid due to the weak carbonic acid formed from the reaction of carbon dioxide and water. Studies indicate that pH ranges between 3 and 5 consistently occur in rainwater falling in areas of the Northeastern United States.

Rainwater in many areas of the United States appears to be characterized by being strongly acid and has the potential to seriously affect ecosystems. Only a

few species of fish can tolerate pH values above or below the range (pH 5 through 9) common to natural waters.

pH RANGES THAT SUPPORT AQUATIC LIFE													
MOST ACID		NEUTRAL										MOST ALKALINE	
1	2	3	4	5	6	7	8	9	10	11	12	13	14
Bacteria	1.0											13.0	
Plants (algae, rooted, etc.)					6.5						12.0		
Carp, suckers, catfish, some insects					6.0			9.0					
Bass, crappie					6.5		8.5						
Snails, clams, mussels						7.0		9.0					
Largest variety of animals (trout, mayfly, stonefly, caddisfly)					6.5	7.5							

Most fish have a narrower range, and some cannot survive a change of 1 pH unit. No matter when the cause may be, increased acidity of water may change (1) the rate of soil and rock leaching, (2) the rate of animal and plant metabolism, and (3) the corrosion of man-made structures.

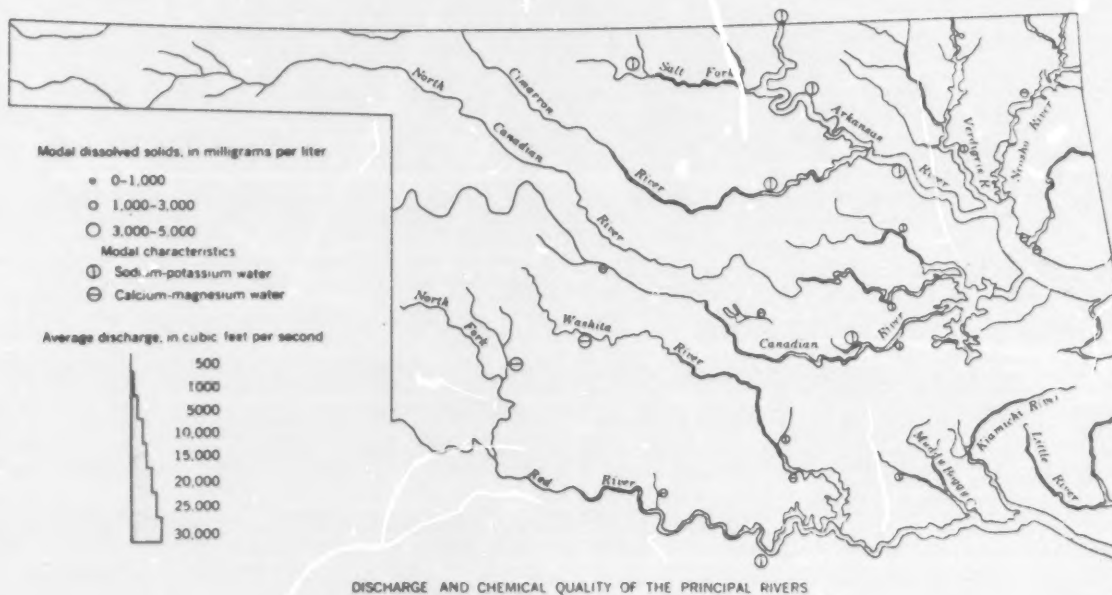
2. Hardness and Salinity

"Hard" water is caused primarily by the presence of calcium and magnesium salts in solution. Hard water when evaporated leaves these salts behind as scale. For many industrial processes where water is evaporated or boiled, this deposit of scale in pipes or boilers creates serious problems. Dissolved calcium and magnesium salts also react with soap in the process of washing and form the well-known "bathtub ring". Rainwater if captured

before passing through soil and rock containing calcium and magnesium compounds is usually soft. Water may be classified as soft if it contains between 0 and 60 parts per million of calcium carbonate. Extremely hard water is classified as having over 180 ppm of calcium carbonate. Hardness of over 500 ppm may be hazardous to human health.

Saline water is any water containing more than 1,000 ppm of any type of dissolved solid. Saline water may be classified as

- | | |
|-----------------|-----------------------------------|
| 1. Brackish | 1,000 to 4,000 ppm |
| 2. Salted water | 4,000 to 18,000 ppm |
| 3. Sea water | 18,000 to 35,000 ppm ⁴ |



Interior-Geological Survey,
Washington, D.C.-1968-W69087

This folder free upon request
to the U.S. Geological Survey

Figure 6 shows average discharge and dissolved solids measured at select sites along Oklahoma's principle rivers. (One milligram/liter = 1 ppm.) This data indicates that much of the river water in Oklahoma would be classified as brackish or salted water.

The cost of creating useable water increases as the amount of total dissolved solids increases. The amount of dissolved solids in water is also an important factor in determining its use for irrigation purposes. Moisture evaporating from irrigated fields leaves behind the salts once dissolved in the water. These materials continue to concentrate in the soil until what once were productive fields become non-producing fields of white salt. Water for irrigation constitutes one of our major needs. Domestic use of water in the United States accounts for only 7 to 8 per cent of the total useable water supply. It is possible that desalination, uneconomical at this time, may in the future provide for a significant part of our domestic use. The price of desalinated water probably will never be low enough for the purpose of irrigation.

Desalination, in addition to requiring considerable energy, also leaves us with the problem of what to do with great quantities of salt. These compounds have to go somewhere. Areas where they are stored could become devoid of life!

3. Dissolved Gases

Gases as well as solids may be dissolved in water. For example, a bottle of carbonated "soda pop" when opened fizzes when dissolved gases are released. Also we are informed that before placing tropical fish in tap water, it should be "aged" to allow chlorine gases to escape. Two important gases dissolved in water are oxygen and carbon dioxide.

Oxygen from the atmosphere is added to water where the two come in contact at the water's surface. Turbulence such as wave action and water tumbling over rapids in streams increases the amount of oxygen absorbed. It is also added to water by the photosynthesis of green aquatic plants. Organisms living in water depend on the presence of dissolved oxygen to sustain life just as land organisms depend on oxygen in the air.

The measurement of dissolved O_2 is probably the best single indication of water quality. Water of high quality will usually contain concentrations of O_2 near the saturation amounts shown in Figure 7.

"The reason for small amounts of dissolved oxygen is usually decomposition of organic material--animal wastes, sewage, or dead plant and animal remains. As bacteria and other decomposer organisms break down these materials, they consume oxygen. When large amounts of organic materials are added to water, either by natural or by human processes, decomposition may reduce oxygen

Figure 7

AMOUNT OF DISSOLVED OXYGEN IN FRESH WATER
AT DIFFERENT TEMPERATURES WHEN EXPOSED TO NORMAL AIR

Temperature °C	Parts/Million	Temperature °C	Parts/Million
0	14.62	16	9.95
1	14.23	17	9.74
2	13.84	18	9.54
3	13.48	19	9.35
4	13.13	20	9.17
5	12.80	21	8.99
6	12.48	22	8.83
7	12.17	23	8.68
8	11.87	24	8.53
9	11.59	25	8.38
10	11.33	26	8.22
11	11.08	27	8.07
12	10.83	28	7.92
13	10.60	29	7.77
14	10.39	30	7.63
15	10.15		

concentrations to very low values or even to zero. Under such conditions, anaerobic organisms (those that can live without oxygen) begin to decompose the organic matter and release gases that are responsible for the characteristic smells of polluted or stagnant bodies of water. In addition to decomposition of organic matter, some kinds of chemical discharges from industries also remove oxygen from water. The concentration of dissolved oxygen is often the factor that determines the kinds of aquatic organisms living in a body of water. Most fish and many aquatic invertebrates--insects, insect larvae, crustaceans, and worms--require 4 to 5 parts per million (ppm) dissolved oxygen for survival. Trout, minnows, and bullheads require larger amounts, 7 to 11 ppm. Carp (the common goldfish is a type of domesticated carp) can survive in water containing as little as 1 or 2 ppm dissolved oxygen.

A clean, flowing stream will also usually have dissolved oxygen concentrations at or very near the saturation levels shown in the table. Lower amounts indicate that wastes such as sewage, runoff from livestock feedlots, or industrial discharges are entering the stream.

The situation in deep ponds and lakes is more complex. Oxygen is added to water by diffusion from the atmosphere, wave action and photosynthesis. These processes take place primarily in the upper layer of a pond or lake and we find the upper strata of water well

oxygenated. In lower layers, oxygen depletion or deficiency may take place due to decay of organic matter on the pond or lake bottom. The two seasonal turnovers in waters of the temperate regions of the world are very important in circulating oxygen to the deeper portions of lakes. Many kinds of aquatic organisms would not survive if it were not for this periodic mixing of water. Figure 7 also points out the decreased ability of water to hold dissolved oxygen as the water temperature increases. Hot water discharged into lakes, rivers, or the ocean may, therefore, be a major cause of oxygen depletion.

C. BIOLOGICAL FACTORS

No two natural bodies of water are alike! The physical and chemical factors differ as does the number and kind of particular plant and animal communities. Each stream, lake, or ocean is a unique ecosystem with fluctuating interactions between physical, chemical, and biological factors.

Biological factors influence physical and chemical qualities of water in a number of ways. For example, in the presence of large amounts of dissolved nutrients (Phosphates, Nitrates, Carbon dioxide), a dense growth of algae called an "algal bloom" may take place. As this dense growth of algae dies, it is decomposed by bacteria. The bacteria consume oxygen in the

decay process and may severely reduce the oxygen available to other living things. In addition, an algal bloom reduces the level to which sunlight can penetrate water and in this way limits the growth of other organisms and alters the chemistry of the water.

1. Habitats in a Lake

When observing three different fishermen, each seeking three different kinds of fish such as catfish, crappie, or bass, it is obvious that different kinds of living things are to be found in different kinds of habitats. Each of the three men fish with different bait, in different locations, at different times. Selecting the right kind of food and placing the food in the right location at the right time are part of the fisherman's art and separate the pro from the amateur. Looking at it another way, if we found a plant like the cattail growing in the middle of a fast moving stream, or an animal like the trout in a warm, stagnant, shallow pond, we would be surprised.

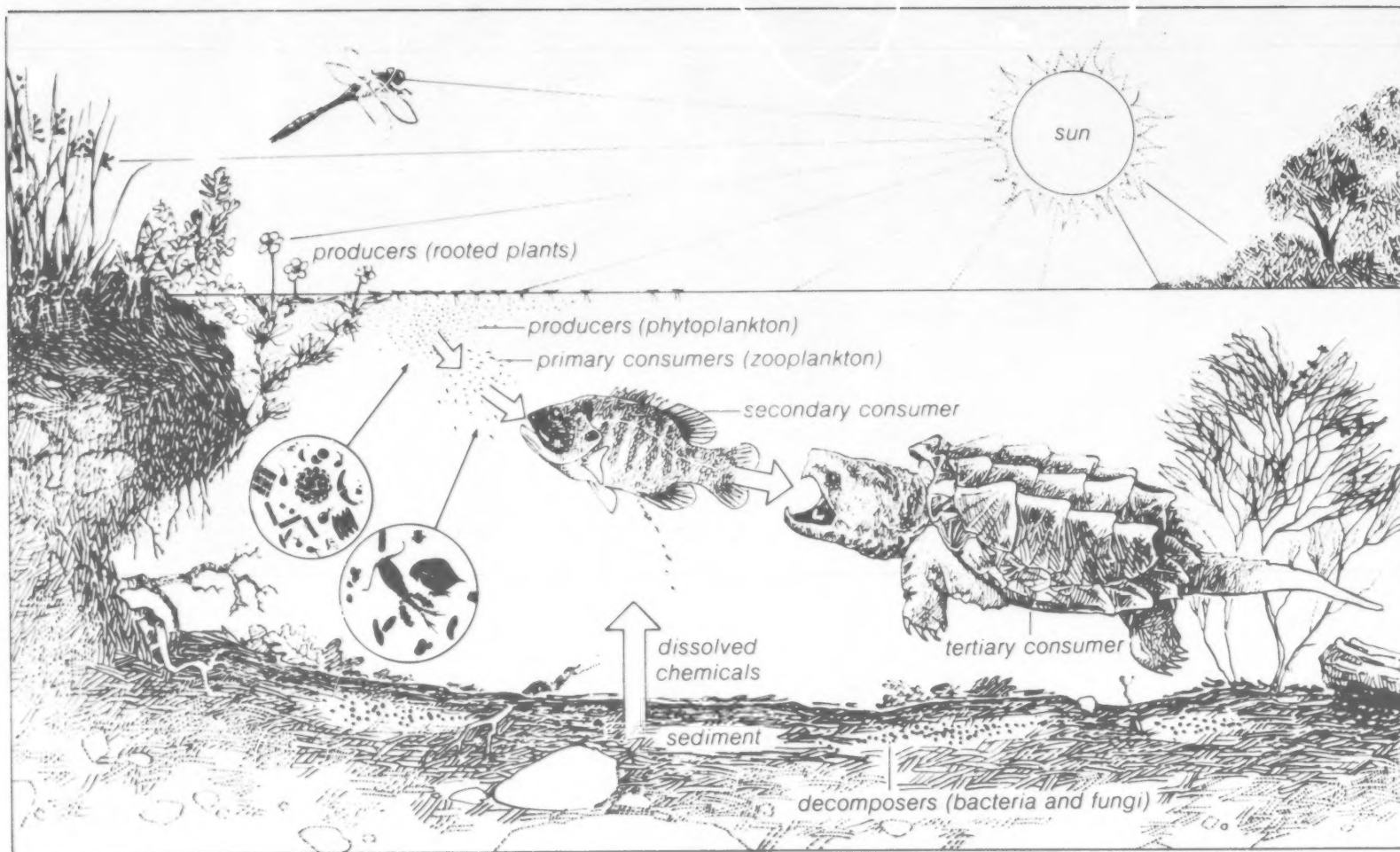
Living things may be grouped as individuals, as populations, and as communities. Single individuals under normal conditions seldom occur in isolation. A population consisting of a number of individuals of the same species likewise seldom occur in isolation from other populations. Populations existing together in a network of relationships are called communities. A community is

a group of organisms existing together by virtue of environmental needs, while communities of organisms considered in relationship with each other and the factors in their environment form an ecosystem. The planet earth, a forest, a decaying log, an aquarium, or a test tube culture may be considered an ecosystem. If it is possible to measure the energy and materials entering and leaving an area, for convenience of study, this area may be called an ecosystem. Ecosystems generally include (1) the non-living or abiotic substances such as water and minerals, (2) producers, such as green plants, (3) consumers, mostly animals, and (4) decomposers, like bacteria and fungi. A pond or lake is an example of an ecosystem. (Figure 8)

An ecosystem such as a pond may be considered as being made up of habitats; i.e., the natural places where organisms live and grow. Figure 8 shows the most common locations in which some aquatic animals may be found and points out that individual organisms may sometime be found in more than one location.

2. Terrestrial Animals

Water is essential to all life. Water is the solvent for substances contained in living cells and is the medium for metabolic processes in general. If an organism is to maintain its normal water content, all the water it loses must be exactly offset by the water it takes up.



A greatly simplified version of a freshwater pond ecosystem.

Figure 8 - Compliments of Wadsworth Publishing Co., Inc.

The greatest physiological threat to life on land is dehydration. Water lost through (1) evaporation from lungs and skin, (2) water in feces, and (3) water in urine must be replenished by gaining water from (1) drinking, (2) water in food, and (3) oxidation of foods. Terrestrial organisms can be conceptualized as life forms which have managed to capture and internalize the waters of the ancient seas from which they evolved. The danger of dehydration is the price payed by land animals for access to increased amounts of oxygen permitting higher rates of metabolism and eventually the evolution of the warm blooded animals.

One of the more uncomfortable human conditions is thirst. A lack of water reduces the secretions of the salivary glands, the mouth and throat dries and we seek water. However, the major stimulus to drink is imbalance of water and salts in the blood. The higher concentration of salts (increased osmotic concentration) signals the hypothalamus of the brain and we seek water. Eating salty foods can also increase the blood's salt content and create "thirst"! Humans require about $1\frac{1}{2}$ quarts of water per day. We can survive around 80 days without food but only a few days without water. The human body requires relatively great amounts of water to "flush" out waste materials and regulate its temperature.

Some terrestrial organisms survive without drinking. The Kangaroo rat, a rodent of the deserts, lives

on seeds and other dry plants and can survive for months without drinking water. The water gain-loss balance is maintained during this period by gaining water from oxidizing food (slow combustion of food produces some water) and preventing loss because they (1) have no sweat glands, (2) are nocturnal (active at night) and (3) possess the ability to excrete body waste in high concentration using little water. The extraordinary kidney of the kangaroo rat can remove wastes in very concentrated urine. Salt in the urine, for example, may be in concentrations twice that of sea water.

3. Diversity of Life

Natural waters have all degrees of salt concentrations from the minimum content of rain water to the saturated solutions of salt lakes. Organisms inhabit all of them--even the most extreme if life is not made impossible by the presence of poisonous materials or by lethally high temperatures. The composition of the organic community is greatly dependent on the salt content of the environment. A limitation of the number of species begins at concentrations exceeding that of the sea. Beyond this level it becomes increasingly difficult for plants and animals to maintain their osmotic balance and the number of species decreases.

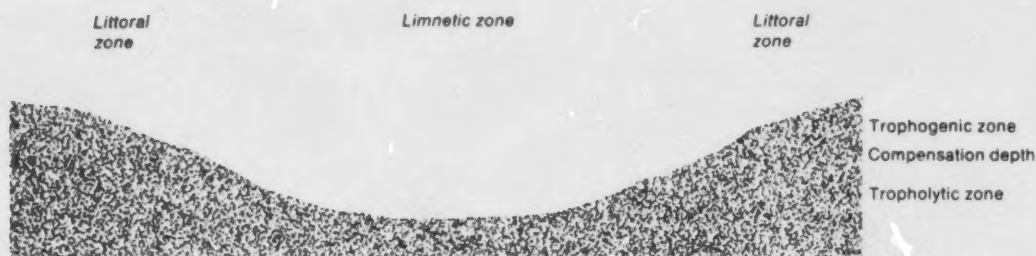
In salt water animals such as fish, water is being lost from body fluids to the more concentrated sea water.

They are in constant danger of dehydration. All fresh water invertebrates as well as fishes and amphibians experience a constant intake of water due to greater concentrations of salts in the body fluid. Improper balance of materials dissolved in water may restrict the diversity of life living in it.

Diversity of life forms is related to the stability of an ecosystem. Lacking diversity of species, an ecosystem may have ecological niches which are unoccupied. With only part of the niches occupied, the system may be less capable of securing and using the energy available and in cycling particular chemicals vital to the system. Preserving stability of an ecosystem requires that we understand the part played by each species and that we do not underestimate the importance of those we do not fully understand. An example would be the campaign in Africa to eliminate the hippopotamus and the crocodile. The removal of these species caused a number of unexpected and counter productive phenomena. The rivers began to clog up, fish began disappearing, and disease spread among the human population. It was found that the hippo and crocodile dig deep holes that maintained the fish in the dry seasons. They also removed vegetation and silt keeping the stream from spreading and becoming shallow and slow moving. The increase in disease resulted from human parasites breeding in the warm shallows. Removal of these two organisms changed the stability of the aquatic ecosystem.

4. Productivity

Many of the same factors governing species diversity also operate on productivity; i.e., the amount of life a system can support. A lake consists of two fundamentally different regions in which two opposing processes take place. These are the regions of photosynthetic production (trophogenic zone) and the region of material breakdown (tropholytic zone).



The upper trophogenic zone is characterized by the formation of food by green plants during photosynthesis. It is here that oxygen is released by plants. As you penetrate deeper water, the less dissolved oxygen is available to support life! The trophogenic zone, composed of the littoral and limnetic subzones, is where the removal of dissolved nutrients takes place as opposed to the tropholytic zone where the resulting breakdown of organic materials produces nutrients which are added to the water.

Productivity relates to the total amount of organic matter that is formed within a certain period of time from the raw materials supplied to the community. Measures of productivity includes establishing the biomass or the amount of oxygen and carbon dioxide being generated. Biomass is the total weight or mass of all living matter in a particular habitat or ecosystem while the amount of oxygen or carbon dioxide indicates the rate of photosynthesis or primary production upon which other life forms depend.

Productivity is limited by the physical, chemical, or biological factor present in the least amount at any given time. For example, free floating aquatic plants in the trophogenic zone multiply and grow by virtue of the nutrients in the water and the sun energy. The nutrients in the water are not necessarily in the amounts corresponding to what is needed. Phosphates for example, are often found in minute amounts. In the absence of phosphate ions, other materials cannot be used and the normal process of photosynthesis may cease. In this case, the lack of phosphate is a limiting factor. Likewise, increases in the physical factor, sunlight have little effect on the rate of photosynthesis unless there is also an increase in temperature. Temperature is a limiting factor here. For example, a pond in the spring, even in the event of strong sunlight penetrating the water, is limited in primary productivity until water

temperatures increase. This phenomena is referred to as the principle of limiting factors.

A CONCEPTUAL SCHEME FOR STUDIES OF AQUATIC ENVIRONMENTS

1. An Abundance of Water Makes the Earth Unique in our Solar System.
 - 1.1 Water has a unique combination of chemical and physical properties.
 - 1.11 The chemical and physical behavior of water results in part from the geometry of the water molecule.
 - 1.12 Within the range of temperatures encountered on earth, water exists in three states: solid, liquid, and gas.
 - 1.13 Water exchanges large amounts of heat as it changes in state.
 - 1.2 Water in the environment contains a variety of substances in suspension and in solution.
 - 1.21 Water is a very effective solvent.
 - 1.22 Dissolved and suspended substances affect the properties of water.
 - 1.23 Water in nature usually contains gases, organic compounds and mineral salts.
 - 1.24 Many substances dissolved or suspended in water are recycled through biological, geological, and chemical systems.
2. Aquatic Environments Interact with the Earth and its Atmosphere.
 - 2.1 Most of the earth's water is in the oceans.
 - 2.11 Oceans formed early in the history of the earth.
 - 2.12 The earth's surface water is constantly recycled through the oceans.
 - 2.2 The ocean waters are influenced by the earth's rotation, revolution, and position in the solar system.
 - 2.21 Ocean current patterns are affected by the absorption of solar energy.
 - 2.22 Ocean current patterns are affected by the earth's rotation.
 - 2.23 Tides result from gravitational forces of the earth, the moon, and the sun.

- 2.3 Energy is transferred wherever bodies of water meet the land or atmosphere.
 - 2.31 Atmospheric movements generate waves, surface currents, and coastal winds.
 - 2.32 Moving water shapes land forms.
 - 2.33 Subsurface topography is constantly changing.
 - 2.34 Land and sea floor movements generate waves.
 - 2.35 The aquatic environment helps to stabilize the earth's climate.
- 2.4 Materials carried from land masses influence the coastal zones.
 - 2.41 Water, ice and wind carry minerals, nutrients, sediments and freshwater into rivers, lakes, and coastal zones.
 - 2.42 Freshwater from the land dilutes the coastal waters.
- 3. Aquatic Organisms Interact in Complex Ecosystems.
 - 3.1 Life probably originated in the marine environment.
 - 3.11 Water facilitated the chemical evolution of organic compounds and coacervates.
 - 3.12 Chemical evolution resulted in heterotrophic systems.
 - 3.13 Autotrophs evolved from heterotrophs.
 - 3.14 Aquatic environments have supported the evolution of a diversity of species.
 - 3.2 Aquatic organisms are adapted to their environments in different ways.
 - 3.21 Aquatic organisms are adapted developmentally, structurally, functionally, and behaviorally to their environments.
 - 3.22 Organisms in aquatic communities interact in balance with their environment and with one another.
 - 3.23 Populations of aquatic organisms are unevenly distributed.
 - 3.3 Aquatic ecosystems depend on a constant flow of energy and the recycling of materials.
 - 3.31 Energy for the maintenance of aquatic ecosystems comes from the sun.
 - 3.32 Aquatic plants convert solar energy to food energy.
 - 3.33 Aquatic bacteria reduce organic materials to simpler forms.

- 3.4 The stability of aquatic ecosystems tends to be directly proportional to the diversity of its populations and the complexity of relationships among them.

4. Man is Part of Aquatic Ecosystems.

- 4.1 Aquatic environments have affected the course of history and the development of human cultures.
 - 4.11 Oceans, lakes, and rivers have served as routes for the dispersal of human populations and cultures and for commercial transport.
 - 4.12 Proximity to aquatic environments and the availability of aquatic resources have influenced the cultures of many societies.
- 4.2 Man's activities may deplete and degrade aquatic ecosystems.
 - 4.21 Exploitation of aquatic environments can cause depletion of many marine and freshwater species and the degradation of habitats.
 - 4.22 Man is changing aquatic ecosystems by adding pollutants to air and water.
- 4.3 Existing technology is capable of maintaining the health and usefulness of aquatic ecosystems.
 - 4.31 The maintenance of the health and usefulness of aquatic environments depends on value judgements and ethical considerations.
 - 4.32 Regional and international agreements will be essential for the conservation of aquatic resources.

USING LANDSAT IMAGERY TO MAKE A MOSAIC OF OKLAHOMA

Purpose

The purpose of this activity is to acquaint the student with the methods that are used to make a mosaic from earth resource satellite images highlighting surface water and applying this data to some applications on earth.

Materials Needed

Scissors	Transparent tape
Ink pen	Oklahoma road map or atlas or aeronautics chart
Ruler	18" X 18" clear acetate over- lay (optional)

Background Information

Within the technology of the space age lies a key to increased knowledge about the resources and environment of the earth. This key is remote sensing. Remote sensing is detecting the nature of an object without actually touching it. Although the photographic camera is the most familiar remote-sensing device, there are also other instrument systems, such as scanning radio-

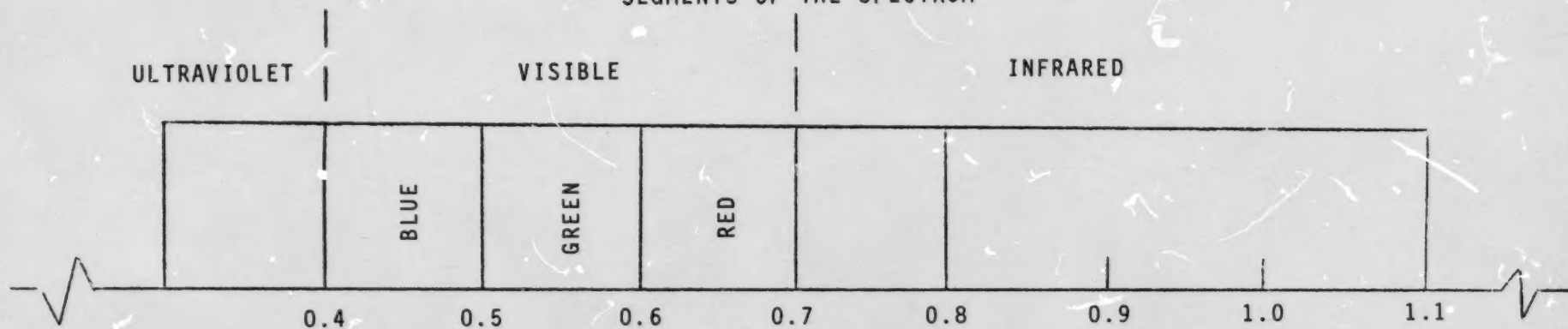
* Copyright 1977 by Steven K. Marks, LANDSAT images may
by obtained from: Dr. Steven K. Marks
College of Education
Oklahoma State University
Stillwater, OK 74074

meters and radar, that can produce photographs and images while aboard satellites and spacecraft.

The NASA Landsat Satellites carry such devices. These satellites are in polar orbit around the earth at an altitude of 567 miles (915 km). The first Landsat satellite was launched on July 23, 1972. Landsat-2 was launched on January 22, 1975. Landsat completes an orbit every 103 minutes, or roughly 14 times per day. Each orbit passes from north to south, and as the earth rotates under its instruments, images are taken of the globe with repetitive coverage every 18 days. Therefore, every 18 days the same image is taken. Each image covers an area of 115 miles (185 km) by 115 miles (185 km). This amounts to over 13,200 square miles on each image every 18 days. Since there are two satellites in orbit, and they are 180° apart, the same image is taken every nine days. The images are taken with a 10% overlap. With this overlap between images larger regions can be pieced together. This activity will demonstrate how this overlap principle is applied. This repetitive coverage provided data for land-use planning, monitoring strip mining, inventory of crops, water resources, geology, exploration of oil, gas, copper and other minerals.

The Landsat satellites have several multispectral sensors aboard. The sensor this activity deals with is the Multispectral Scanner (MSS). This instrument scans

Figure 1
SEGMENTS OF THE SPECTRUM



MICROMETERS
(10^{-6} meters)

MSS

Band 4

Band 5

Band 6

Band 7

in four different wave bands. The bands are green, red, and two infrared. The wave bands are shown in Figure 1, and the following is a description of each band.

A. Green, .5 - .6 X 10⁻⁶m, Band 4

Light of this spectral range appears green to the eye. Water is more or less transparent in this band, which enhances features within the water, like sedimentation. This band has some limitations because scattering of light in the atmosphere makes "seeing" conditions difficult.

B. Red, .6 - .7 X 10⁻⁶m, Band 5

This band appears red. Unlike band 4, this band is excellent for "seeing" through the atmosphere from space. It is especially good for land-use mapping where regional population patterns need to be observed against vegetation patterns. The red band shows a good contrast between natural surface cover, like vegetation and soil, against man-made structures. Soil which has become exposed due to man-made activity can be seen in this band.

C. Infrared, .7 - .8 X 10⁻⁶m, Band 6

Infrared, .8 - 1.1 X 10⁻⁶m, Band 7

Things look different to instruments in the infrared as compared to the visible. The most significant characteristic about infrared bands is that vegetation appears bright, and water appears dark. As a

comparison, vegetation is as bright in the infrared as snow is in the visible.

The sensors on board the satellite transmit the images to receiving stations in Alaska, California, and Maryland.

Using Landsat images of Oklahoma and the world, various widespread benefits can be collected in such areas as:

- A. Agriculture - Land-use planning, range management, identification and combating crop diseases and improving irrigation planning.
- B. Geology - studying earthquake fault systems, and aid in identifying terrain features associated with oil and mineral deposits.
- C. Hydrology - detecting water pollution trends, monitoring floods, inventory of surface water in lakes, reservoirs, and rivers.
- D. Geography - produce updated maps showing changes in the earth's surface, natural or man-made.
- E. Oceanography - studying ocean currents and biological phenomena in the oceans.

Making the Oklahoma Mosaic

1. Transfer the number from the front of the image to the center of the back, starting with the top image.
2. Unstaple and cut each of the images along the edge, so as to not cut into the image, but leaving no border.

3. Lay out each of the seven images flat on the table next to each other.
4. Look along the outer portion of the images for two physical features that are the same. Once you have located two features, lay one feature exactly over the other and temporarily tape on the front or back.
5. Continue this method until all of the seven images are taped together.
6. If you cannot match the images, see the key for the right combination.
7. Next, obtain an Oklahoma road map or atlas and locate Lake Texoma on the map and the completed mosaic. This will determine what the directions are on the mosaic.
8. Next, pencil in the borders of Oklahoma on the mosaic using rivers, agriculture field, and/or mountains.
9. Once you have determined the borders, this will provide a reference for future activities.

A General Description of Your Oklahoma Mosaic

The mosaic images you just compiled were taken by combining several Landsat images into seven to save time, but the process is exactly the same using actual images. Your mosaic was taken in band 7 from July-October, 1972. Water in this infrared band will be black, because the water almost totally absorbs the radiant energy in these frequencies. In this infrared

band (invisible to the human eye), vegetation appears bright in contrast with the dark water. Man-made structures, such as cities and highways are difficult to discern.

Suggestions for Further Activities

Note to the teacher--The following is a list of suggested general activities. Within each activity many additional activities can be produced. These suggested activities are general in nature to show only the wide range of possibilities that can be used in every type of classroom. The use of the mosaic can be used in social studies, economics, physics, earth science, or geology. It is hoped that each teacher will expand this activity to meet their own teaching goals.

Activities:

1. Identify the following gross surface features by using a road map and your mosaic:

A. Lake Keystone	G. Ouachita Mountains
B. Red River	H. Great Salt Plains
C. Lake Texoma	I. Cimarron River
D. Arkansas River	J. South Canadian River
E. Oklahoma City	K. Robert S. Kerr Reservoir
F. Tulsa	L. Your hometown
2. Make a list of the surface features that are not visible on the mosaic.

3. Make a scale for your mosaic.
e.g. 1 cm = ? km
or 1 cm = ? miles
or 1 in. = ? miles (as a last resort)
4. Make a geologic overlay using clear acetate for the mosaic using the major geologic formations in Oklahoma.
5. Develop a land use overlay using clear acetate for developing the growing urban areas of Oklahoma as well as agriculture development, by taking into consideration the air, land, and water environment and resources of Oklahoma.
6. Develop an overlay depicting the average rainfall for Oklahoma. Also compare and contrast yearly rainfall amounts for various years in Oklahoma.
e.g. 1933
1944
1965
1976
7. Develop a soils map depicting the type of soil and its relationship to range management across the state.
8. Develop an overlay using clear acetate depicting a contour map of Oklahoma.
9. Develop an overlay showing the pioneer trails and historical development of Oklahoma.

10. Develop a clear acetate overlay depicting an energy fuels map of Oklahoma.

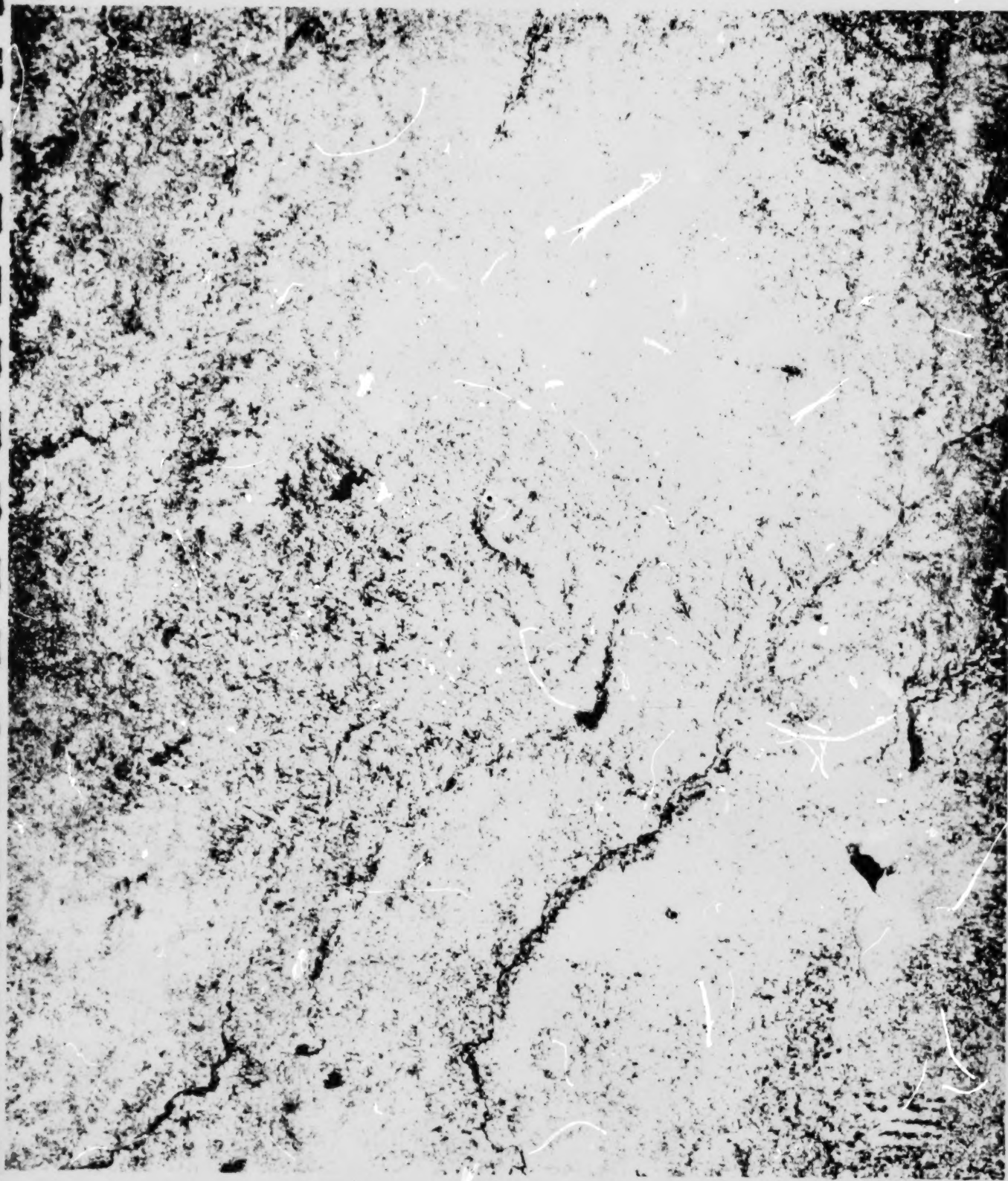
For information on how to order more Landsat and aircraft imagery, write to:

EROS Data Center
Sioux Falls, SD 57198

Combination for arranging images:

7	3	6
	2	1
	5	4





2

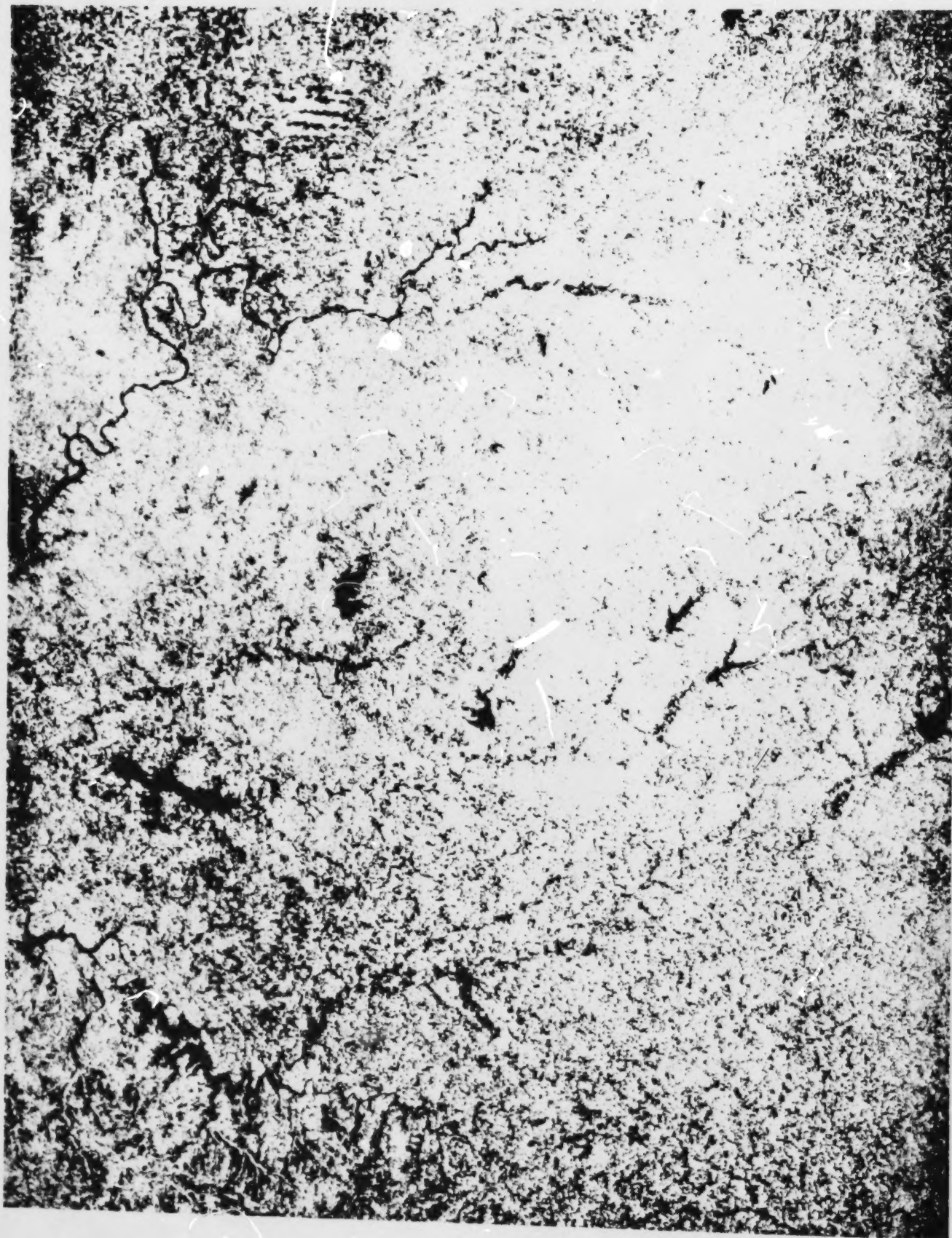
117







120





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122

RESOURCES

Chapter References

- Abruscato, Joe, and Jack Hassard, The Whole Cosmos, Catalog of Science Activities, Goodyear Education Series, Theodore W. Hipple, Editor, Goodyear Publishing Co., Inc., Santa Monica, California, 1977.
- Andrews, William A. (Ed.), Contours: Studies of the Environment, Freshwater Ecology, Prentice Hall, Inc., Englewood Cliffs, New Jersey, 1972.
- Bradley, Charles C., "Human Water Needs and Water Use in America," Book VIII, Water Quality, Environmental Resource Papers, BSCS, Addison-Wesley Publishing Co., Menlo Park, California, 1975.
- Cleveland, John M., Physical Science, Charles E. Merrill Books, Inc., Columbus, Ohio, 1964.
- "Conservation and the Water Cycle," Soil Conservation Service, Agricultural Information Bulletin No. 326, Superintendent of Documents, U.S. Government Printing Office, Washington, D.C., 1973.
- A Curriculum Activities Guide to Water Pollution and Environmental Studies, Vol. II, Institute for Environmental Education, Cleveland Heights, Ohio, 1971.
- Environmental Education Instructional Activities Booklet, Oklahoma State Department of Education, Allied Printers and Publishers, Inc., Oklahoma City, Oklahoma, 1975.
- Geens, Maura and Robert W. Stegner, "A Conceptual Scheme for Studies of Aquatic Environments," School of Education, University of Delaware, Maryland, 1976.
- Hill, Gladwin, Cleansing our Waters, Public Affairs Pamphlet No. 497, Public Affairs Committee, Inc., New York, Feb., 1974.
- Investigating Your Environment, BSCS, Addison-Wesley Publishing Co., Menlo Park, California, 1975.

- Kitchen Physics, Elementary Science Study, McGraw Hill Book Co., New York, 1967.
- Landers Cards, Landers Conservation Center, Landers, Wyoming, 1972.
- Likens, Gene E., F. Herbert Bormann, and Noye M. Johnson, "Acid Rain," Book VIII, Water Quality, Environmental Resource Papers, BSCS, Addison-Wesley Publishing Co., Menlo Park, California, 1975.
- Mapp, Harry P. Jr. and Vernon R. Eidman, "A Bioeconomic Simulation Analysis of Regulating Groundwater Irrigation," American Journal of Agricultural Economics, Vol. 58, No. 3, Aug., 1976.
- Marks, Steve, "Using Landset Imagery to Make a Mosaic of Oklahoma," College of Education, Oklahoma State University, Stillwater, Oklahoma, 1977.
- McGavock, John, and Donald P. LaSalle, Guppies, Bubbles, and Vibrating Objects, The John Day Co., New York, 1969.
- Miller, Tyler G. Jr., Living in the Environment. Concepts, Problems, and Alternatives, Wadsworth Publishing Co., Inc., Belmont, California, 1975.
- "Outdoor Biology Instructional Strategies, Set I," Lawrence Hall of Science, University of California, Berkeley, California.
- Reed, Elizabeth Wagner, "Temperature Distribution in Water," The Science Teacher, Vol. 38, No. 1, Jan., 1971.
- Reynolds, Karen E., "Measuring Turbidity with Two-Way Secchi Disc," The Science Teacher, Vol. 43, No. 5, May, 1976.
- Ruttner, Franz, Fundamentals of Limnology, University of Toronto Press, 1969.
- Schmidt-Nielsen, Knut, Animal Physiology, Foundations of Modern Biology Series, Prentice Hall, Englewood Cliffs, New Jersey, 1962.
- Science Inquiry for Kindergarten and Primary, Division of Instruction, Tulsa Public Schools, Tulsa, Oklahoma, 1973.

Small Things, An Introduction to the Microscopic World,
Elementary Science Study, McGraw Hill Book Co.,
New York, 1967.

Smith, Frederick E., "Natural Systems," Vital Views of
the Environment, Edited by Mary E. Hawkins,
National Science Teachers Association, Wash-
ington, D.C., July, 1973.

Teaching Materials for Environmental Education, Investi-
gating Your Environment, Forest Service, U.S.
Department of Agriculture, Washington, D.C.,
July, 1973.

Water Resources Investigations in Oklahoma, United States
Department of the Interior, Washington, D.C.,
1968.

We Can Help: A Teachers Guide to Environmental Educa-
tion Activities, U.S. Fish and Wildlife Ser-
vice, Department of the Interior, Jenny Pub-
lishing co., Inc., Minneapolis, Minnesota,
1975.

GOVERNMENT RESOURCES

Association of State and Interstate Water
Pollution Control Administrators
P.O. Box 11143
Richmond, Virginia 23230
Telephone: 703/770-2241

Provides information on state and interstate activities in water pollution control. Provides referral services to various state officials.

Bureau of Outdoor Recreation
Division of Information
U.S. Department of the Interior
Washington, D.C. 20240

Bureau of Sport Fisheries and Wildlife
Office of Conservation Education
U.S. Department of the Interior
Washington, D.C. 20240

Bureau of Water Hygiene
National Center for Urban and Industrial Health
U.S. Environmental Control Administration
222 East Central Parkway
Cincinnati, Ohio 45202
Telephone: 513/684-3571

Answers inquiries on protection of waters polluted by various means. Concerned with health aspects of water pollution. Provides references and makes referrals.

Committee on Merchant Marine and Fisheries
U.S. House of Representatives
Room 1334, Longworth House Office Building
Washington, D.C. 20515
Telephone: 202/225-4447

This committee answers questions and provides services in the form of committee prints and various publications on water pollution control, including legislation. Covers water pollution and its effects on marine life.

Committee on Public Works
U.S. House of Representatives
Room 2165, Rayburn House Office Building
Washington, D.C. 20515
Telephone: 202/225-4472

Answers questions and provides services in the form of committee prints and various publications on water pollution control, including legislation.

Committee on Public Works
U.S. Senate
Room 4204, New Senate Office Building
Washington, D.C. 20510

This committee answers questions and provides services in the form of committee prints and various publications on water pollution. A film is available for loan or sale entitled Troubled Waters.

Consumer Protection and Environmental Health Service
Office of Public Affairs
U.S. Department of Health, Education and Welfare
Washington, D.C. 20204

Environmental Hygiene Agency
Office of the Surgeon General
U.S. Department of the Army
Edgewood Arsenal, Maryland 21010
Telephone: 301/671-4236

Answers questions and provides other services to military and government agency personnel on environmental health and hygiene. Provides data on water pollution control measures for health.

Federal Water Pollution Control Administration
Office of Information
U.S. Department of the Interior
Washington, D.C. 20242

National Wildlife Federation
1412 16 Street, NW
Washington, D.C. 20036

New England Interstate Water Pollution Control Commission
73 Tremont Street, Room 950
Boston, Massachusetts 02108
Telephone: 617/742-0281

This commission answers questions and provides referral services concerning water pollution control activities in the six New England states region. Publishes an annual report and a newsletter. Maps, charts, and photographs for on-site use are available.

Office of Public Information
U.S. Federal Water Quality Administration
Washington, D.C. 20242
Telephone: 703/557-7373

Answers inquiries, provides consulting and limited reference services, provides bibliographic citations and abstracts, and makes referrals. Makes available in many forms all IWGA research and development efforts.

Director, Oklahoma Geological Survey
The University of Oklahoma
Norman, Oklahoma 73069

Director, Oklahoma Water Resources Board
2241 Northwest 40th Street
Oklahoma City, Oklahoma 73112

Soil Conservation Service
Information Division
U.S. Department of Agriculture
Washington, D.C. 20250

Technical Library
U.S. Tennessee Valley Authority
500 Union Avenue, S.W.
Knoxville, Tennessee 37902

This organization answers inquiries, provides materials for interlibrary loan on the TVA's efforts in the field of water pollution control. Publishes three annual bibliographies on its activities.

Water Resources Division
Geological Survey
U.S. Department of the Interior
18th and F Streets, NW
Washington, D.C. 20242
Telephone: 202/343-3595

Answers inquiries on water quality, including water pollution and pollution control. Makes references to Geological Survey publications.

Water Resources and Engineering Services Division
Bureau of Domestic Commerce
U.S. Department of Commerce
14th Street and Constitution Avenue, NW
Washington, D.C. 20230
Telephone: 202/967-4347

Provides assistance to industries and individuals concerning various programs in water pollution control, especially to engineers.

PRIVATE ORGANIZATIONS

American Public Health Association
1740 Broadway
New York, New York 10019
Telephone: 212/245-8000

This organization publishes Standard Methods for the Examination of Water and Waste Water (12th ed., 1965).

American Society of Sanitary Engineering
228 Standard Building
Cleveland, Ohio 44113
Telephone: 216/621-8520

Answers questions and provides reference and referral services on control of water pollution for sanitary conditions. Provides services especially to sanitary engineers.

American Water Resources Association
P.O. Box 434
Urbana, Illinois 61801
Telephone: 217/367-9695

Publishes and sells Water Resources Abstracts, monthly; Hydata, annually. Provides a Hydata Reader Service which furnishes papers or abstracts indexed in Hydata.

American Water Works Association
2 Park Avenue
New York, New York 10016
Telephone: 212/686-2040

Collects and disseminates information on water, water technology, water treatment, and related fields. Publishes its Journal monthly.

Committee D-19 on Water
American Society for Testing and Materials
1916 Race Street
Philadelphia, Pennsylvania 19103
Telephone: 215/569-4200

Develops test methods; provides information through its publications.

IDRES Information Center
(Institute for the Development of Riverine and Estuarine Systems)
Science Information Services
Franklin Institute Research Laboratories
Benjamin Franklin Parkway at 20th Street
Philadelphia, Pennsylvania 19103
Telephone: 215/448-1485

Provides information services for a fee depending on time and staff involved. Distributes publications on water pollution control activities in river and estuary systems.

National Council of the Paper Industry for Air and Stream Improvement
103 Park Avenue
New York, New York 10017
Telephone: 212/889-5416

This organization answers and provides services in the form of its publications including Monthly Bulletin, Regulatory Review, and other varied reports.

National Water Institute
744 Broad Street, Room 3405
Newark, New Jersey 07102
Telephone: 201/623-1727

This organization serves as the public relations arm of the Water and Waste Water Equipment Manufacturers Association. Answers questions and provides pamphlets and booklets on water pollution control.

Oklahoma Water Incorporated
Robert S. Kerr, Jr., President
625 Fidelity Plaza
Oklahoma City, Oklahoma 73102

U.S. National Committee
International Association on Water Pollution Research
3900 Wisconsin Avenue, NW
Washington, D.C. 20016
Telephone: 202/362-4100, ext. 3741

This committee answers inquiries on the activities of the U.S. Committee in relation to the international community on water pollution control progress and projects.

Water Conditioning Research Council
325 West Wesley Street
P.O. Box 651
Wheaton, Illinois 60187
Telephone: 213/668-8892

Cosponsored by the Water Conditioning Association International and the Association of Water Conditioning Equipment Manufacturers, this organization answers questions and provides referral services in the field of water pollution control.

Water Information Center, Inc.
Water Research Building, Manor haven
Port Washington, New York 11050
Telephone: 516/883-6780

This center answers questions and provides consulting services for a fee. It publishes Water Newsletter, semi-monthly; Research and Development News, monthly, Water Atlas of the United States; and Water Encyclopedia. All publications are for sale by the center.

Water Pollution Control Federation
3900 Wisconsin Avenue, NW
Washington, D.C. 20016
Telephone: 202/362-4100

The WPCF answers questions free of charge and provides reference, referral, advisory, and consulting services. It publishes Journal: Water Pollution Control Federation, monthly. It also permits on-site use of collection by appointment.

Films and Filmstrips

Educator's Progress Service, Inc.
P.O. Drawer E
Randolph, WI 53956

Educator's Guide to Free Science Materials. Environmental Education films are listed. Cost of Guide - \$9.25.

Environment Information Center, Inc.
Film Reference Department
124 E. 30th Street
New York, NY 10016

The Environment Film Review. A Critical Guide to Ecology films. Lists numerous films available on free loan; also rental and purchase films. Cost: \$20.00.

Joint Council on Economic Education
1212 Avenue of the Americas
New York, NY 10036

Economic Topic Series 1969-70. "The Economics of Pollution" Cost - \$1.00. Has bibliography and films listed; also available free from:
The Calvin K. Kazanjian Foundation, Inc.
P.O. Box 452
Wilton, WI 06897

Modern Talking Picture Service, Inc.
1411 Slocum Street
Dallas, TX 75207

Recommended Film: World Beneath the Sea

Modern Talking Pictures
Film Scheduling Center
2323 New Hyde Park Road
New Hyde Park, NY 11040

Recommended Films: Land of the Sea; Man and a River; Sea Probe.

NEA - ACT
Publications - Sales Sections
1201 Sixteenth Street, N.W.
Washington, D.C. 20036

Project Man's Environment. "Man and His Environment" - An introduction to using environmental study areas (contains programs and good bibliography, including films). Cost: \$1.75.

National Geographic Society
Educational Services, 9999
17th & M Streets, N.W.
Washington, D.C. 20036

Recommended Films: Places Where Plants and Animals Live;
Small Worlds of Life.

Oklahoma Department of Wildlife Conservation
1801 N. Lincoln
Oklahoma City, OK 73105

Some 120 film titles are available free - good to create
interest and perhaps develop appreciation. Recommended
Films (Free): The Aging of Lakes; Waterfowl--A Resource
in Danger.

Oklahoma State Department of Health
Public Health Education
Attention: Film Library
10th and Stonewall
Oklahoma City, OK 73105

Ask for Film Catalog - free films.

Shell Oil Company (Films)
50 W. 50th Street
New York, NY 10020

Recommended Film: The River Must Live (Filmed in Europe).

Singer Society for Visual Education Division
1345 Diversey Parkway
Chicago, IL 60614

Communications in Nature; Ecology Learning Module contains
filmstrips, cassettes, guides, community murals, game
boards, wall charts, student evaluation books, and teacher's
manual. For primary and intermediate grades. Module may
be purchased complete or as sub-sets.

Steck-Vaughn Company
P.O. Box 2028
Austin, TX 78767

The ABC's of the Total Environment; and The Total Envi-
ronment Kit; a multi-disciplinary, multi-media program
for middle to upper elementary grades.

U.S. Department of HEW
Public Health Service
Public Affairs Office
Environmental Health Service
Rockville, MD 20852

Variety of good materials available in packet form; includes free films on pollution.

Books, Pamphlets, and Articles

Air Pollution, Pesticides, Water Pollution, Hunger, Environmental Education, Nuclear Explosives in Peacetime, Environmental Effects of Weapons Technology, Environmental Cost of Electric Power, Law and the Environment. Nine Workbooks @ \$6.00 for the set. Scientists' Institute for Public Information, 30 East 68th Street, New York, NY 10021.

Clean Water and the Dairy Products Industry. EPA Public Information Center (PM-215), Washington, D.C. 20460, July, 1976.

Clean Water - It's Up To You (free), Izaak Walton League of America, 1326 Waukegan Road, Glenview, IL 60025, 1970.

Conservation vs. Pollution, U.S. Department of Agriculture Soil Conservation Service, Stillwater, OK 74074, June, 1970.

Conserving our Waters and Clearing the Air, Free study unit for science and social studies classes (gr. 10-12); contains teacher's guide. American Petroleum Institute, 1271 Avenue of the Americas, New York, NY 10020, 1968.

A Curriculum Activities Guide to Water Pollution and Environmental Studies, \$15.00 for Vols. I and II (paperback or loose-leaf, 3-ring drilled copies), Institute for Environmental Education, 8911 Euclid Avenue, Cleveland, OH 44106

A Drop to Drink, A Report on the Quality of our Drinking Water, EPA Public Information Center, Washington, D.C. 20460, June, 1976.

Environmental Education Instructional Activities Booklet, Dr. Leslie Fisher, Oklahoma State Department of Education, Oklahoma City, OK 73105.

EPA, EPA Public Information Center, Washington, D.C. 20460, September, 1975.

Fish Shelters Provide Better Fishing, Oklahoma Department of Wildlife Conservation, 1801 N. Lincoln, Oklahoma City, OK 73105.

Fishes of Oklahoma, 50 cents, Oklahoma Department of Wildlife Conservation, 1801 N. Lincoln, Oklahoma City, OK 73105.

Forests and Water, U.S. Department of Agriculture, Forest Service, Washington, D.C. 20250.

Gordon, Glen. The Delicate Balance - An Environmental Chemistry Module, Harper & Row, New York, 1973.

Great Salt Plains Dam and Reservoir, U.S. Corps of Engineers, Tulsa, OK 74100.

Green America - Water, Spring, 1976, Vol. 4, No. 1, A Quarterly publication of the American Forest Institute. Green America, American Forest Institute, 1619 Massachusetts Avenue N.W., Washington, D.C. 20036.

Heated Water from Power Plants, U.S. Energy Research & Development Administration, Office of Public Affairs, Washington, D.C. 20545.

How to Catch a Fish in Fresh Water, Outdoor Education Project, Michigan State University, 403 Erickson Hall, East Lansing, MI 48824.

Krockover, Gerald, "Pollution Studies," Science and Children, March 1973, Vol. 10, No. 6, p. 27.

Man . . . An Endangered Species, The Third Wave, The Population Challenge, Quest for Quality, It's Your World, River of Life. Series of six conservation yearbooks, \$9.75 for the series. Superintendent of Documents, U.S. Government Printing Office, Washington, D.C. 20402.

Outdoor Oklahoma - provided free (one copy per school, usually sent to the school library). Oklahoma Department of Wildlife Conservation, 1801 N. Lincoln, Oklahoma City, OK 73105.

Planning Process/Work Program, Statewide 208, Areawide Waste Treatment Management Program, Department of Pollution Control, Oklahoma City, OK 73105, June, 1976.

Autub, Musa Y., Secondary Environmental Science Methods, Charles E. Merrill Publishing Co., Columbus, OH 43200, 1973.

Reid, George K., Fond Life, Golden Nature Guides, Golden Press, New York, Western Publishing Co., Racine, WI 53400.

Selenite Crystals, Salt Plains National Wildlife Refuge, Jet, OK 73749.

Sport Fish of Oklahoma, Oklahoma Department of Wildlife Conservation, 1801 N. Lincoln, Oklahoma City, OK 73105.

Suggestions for Teaching Conservation (Unit Preparation).
Grades 1-12. Texas Education Agency, 201 East 11th
Street, Austin, TX 78711.

Teachers' Guide for Environmental Education, The North
Carolina Department of Public Instruction, Raleigh NC
27602.

Voss, Gilbert L., Oceanography, Golden Science Guides,
Golden Press, New York, Western Publishing Co., Racine,
WI 53400.

Water Pollution, Department of Pollution Control, State
Capitol, Box 53431, Oklahoma City, OK 73105.

Weber, M.C., "The Whoopers are Coming . . . Again,"
Outdoor Oklahoma, Vol. 32, No. 3, p. 5, March, 1975.

What You Can Do About Water Pollution, Federal Water
Pollution Control Administration, U.W. Department of the
Interior. Superintendent of Documents, U.S. Government
Printing Office, Washington, D.C. 20402 (15 cents).

Zim, Herbert S., and Hurst H. Shoemaker, Fishes, Golden
Nature Guides, Golden Press, New York, Western Publish-
ing Co., Racine, WI 53400.

ACTIVITY I

Purpose: To investigate the effects of detergents and fertilizers on the relationship between organisms and their environments.

To provide opportunity to increase observations, inferring, hypothesizing, and communication skills.

Materials: (For each group of six students)

1. Six quart glass containers
2. Pond water with organisms such as:
 - a. Elodea and algae
 - b. Daphnia
 - c. Detergent and fertilizer containing phosphate
 - d. Hand lens

Procedure: Fill six glass jars of the same size half full of water. Number the jars 1 to 6. Put freshwater plants in the following: elodea in jar 1, algae in jar 2, elodea and algae in jar 3. In each of jars 4, 5, and 6, put 10 daphnia (water fleas). Label each jar with the name of the material placed in the jar. Set jars 1 and 4 in a window. Do not add anything to them.

For the rest of the jars, detergent and fertilizer each containing phosphate will be needed. (Label on packages will give ingredients.) Be sure not to breathe in the dust from the powdered soap or fertilizer package.

Put one-half teaspoon of the detergent in jars 3 and 5. Label the jars. Put three teaspoons of the phosphate fertilizer in each of jars 2 and 6. Label the jars.

Carefully examine all the jars the next day. What happened to the daphnia in jars 5 and 6? Record your observations.

After three or four days, what has happened to the elodea in jar 3 and the algae in jars 2 and 3? Record your observations.

What conclusions can you draw from this experiment? Might some of the substances in the detergent and the fertilizer be the same? How might large amounts of these substances affect the plant and animal life in our streams and rivers? Think of ways these substances get into our streams. How can we prevent this?

ACTIVITY II

Purpose: To develop the concept that water dissolves many things, man pollutes water, and materials in water may be harmful.

Materials: (For each group of six students)

1. Salt, sugar, sand, ink, oil (one teaspoon each)
2. Small pieces of wood, candy, chalk, soap, carrot, rock, beans, marbles, tacks
3. Eight small, clear pill vials with watertight lids
4. Twelve pipe cleaners

Procedure: Place one kind of material in each of the containers and fill them with water. Fill one bottle with water, but place nothing in it. This will be the control for later comparison.

Cover and label each container. Now shake them well. What happens to the materials in the water? (Some dissolve, some diffuse, and others just sink to the bottom.) Ask the children to carefully describe what they see. Leave the containers and observe them for a few days.

After three days, open the containers and examine them as follows: Look, smell, - do not touch or taste.

Now, pour all the waters together into a large jar. Ask the children if they would like to drink this water. (No) Help them to realize that water can be made unfit for use if care is not taken. Discuss the problems facing mankind from the spreading contamination of water.

(Salt and sugar completely dissolve in water. Coffee dissolves slightly. Ink discolors water, some dissolves; some will sink to the bottom, as will sand, marbles, and tacks. Tacks may rust. Oil will be separate from the water. Beans will absorb water and become soft and swollen. Candy, chalk, soap, and carrot will be softer and will dissolve slightly.)

Have the children insert a clean pipe cleaner into a glass of clean water. Do the same in the polluted water. Have children observe and compare the two pipe cleaners. Invite children to smell the two containers of water and compare. Ask: In which kind of water would you like to play and

swim? Why? What living things make their homes in water? (Plants, fish.) Do you think that fish and plants could live in the greasy, dirty water? Explain that there must be air present in water for plants and animals to live--that trash and grease use up the air.

Ask children to select pictures showing water pollution. Select clean water pictures and discuss what is good and beautiful in each. Ask children to: Look for ways that people use clean water. Keep a record of how many times they turned on a water faucet in one day. Record the totals for the class. Discuss the reasons the tap is turned on. Keep a record of the amount of time a faucet runs when the child brushes his teeth at home. Could he brush the same number of times a day but shorten the time the faucet runs?

Purpose: To provide students with open-ended tasks in which they select the ways and means of gathering information or solving a problem.

Materials: Determined by the student's plans of how to attack the task.

Procedure: Let the student select a task to do either in class or at home!

1. Heat some ice cubes. How is the form of water changed?
2. Have a contest to see who can keep an ice cube in the classroom for the longest period of time.
3. Try to make water the hottest you can. Coldest.
4. Dissolve some things in water and then try to get them back.
5. Put salt in water; then make it drinkable.
6. Use a plant to move water from a lower place to a higher place and prove it!
7. Plant some seeds in water with detergent in it.
8. In a small, shallow container make an oil slick on water--then separate them.
9. Find out how much water you need each day. In your lifetime.
10. List ten water sources that are on earth but are not related to your life. Then prove how all of them are related to your life.
11. Describe a person who comes from another planet that has no water.
12. Create a one minute commercial about water.
13. Use some water--then plan how you will reuse it.
14. Wet your finger--why is it feeling cool?
15. Put the same amount of water in a shallow pan and in a small mouth jar and put them in sunlight. Slow down the water loss in one of them.

16. Tell the story of a drop of rain.
17. Filter some muddy water.
18. Siphon some water.
19. Using water, make a home for something alive.

ACTIVITY IV

Purpose: To assist the student to differentiate between observations and inferences. To explore some physical properties of water, such as adhesion, cohesion, reflection, surface tension, etc.

Materials: (For each student)

1. Eye dropper (medicine dropper)
2. Toothpicks (a few)
3. Small container (baby food jar) one-half filled with water
4. Pencil and paper
5. 6" X 6" sheet of waxed paper
6. Liquid detergent
7. Cooking oil

Procedure: Have pupils place one drop of water on the piece of waxed paper and list all the observations they can make. After a few minutes, ask to see the hands of those who have three observations, five observations, etc. Do this periodically until it appears the pupils have exhausted their observations. Gather up the materials.

Acting as recorder, list all the different observations made by all pupils on the blackboard. Accept and list all pupils' observations.

Analyze the list. With the class, look for observations that stated "how much" or quantified the observation, i.e., "The drop magnifies things--makes them twice as big," or "the drop sticks to the toothpick more than it does to the waxed paper." Determine which of the five senses were used for each observation. Some typical pupil responses (No two lists are ever alike).

- a. Wet
- b. Reflects
- c. Breaks apart
- d. Round, dome-shaped, oval
- e. Pieces touching are attracted to each other
- f. Clear
- g. Slides on waxed paper
- h. Rolls on waxed paper
- i. Sticks to the toothpick
- j. Doesn't smell
- k. No taste
- l. Sticks to itself

Some of the "observations" generated are "inferred" properties or words that are names for something not associated with the observations made through the senses.

Discuss:

1. Does water roll or slide? What "observation" makes you believe it either rolls or slides?
2. What do you see, feel, smell, hear, or taste that makes you say something is "wet", "reflects" or is "clear"?
3. Have students observe the properties of a drop of soapy water and then a drop of cooking oil. List and compare observations of a drop of water, soapy water, and oil.
4. Have students predict which of the three drops placed on waxed paper would win the race if the waxed paper is tilted.

What does soap do to water?

Does water, soapy water, or oil have the greatest "stickyness" for waxed paper?
What observations led you to believe this?

This type of activity can provide the teacher with insight to the concepts held by children. Often such statements as, "Oil is heavier than water," provide knowledge of misconceptions held by the student and lead to further activities.

Throughout the entire activity wherever disagreement occurs, provide the materials for the student to make additional observations as the means to settle the controversy.

ACTIVITY V

Purpose: To demonstrate the effect of temperature on the movement of water causing thermal stratification.

Materials: (For each group of six pupils)

1. A clear plastic shoe box or its equivalent
2. Two alcohol thermometers (red liquid indicator)
3. Tray of ice cubes
4. Water
5. Food coloring
6. Medicine dropper

Procedure: Measure and record the temperature of water placed in the clear box. Measure the temperature of water in corners, top, bottom, etc. Students should find that various temperatures are similar.

Tape two thermometers to the inside of the box at opposite ends; one with the bulb near the surface of the water and the other with the bulb near the bottom of the box as in Figure 1.

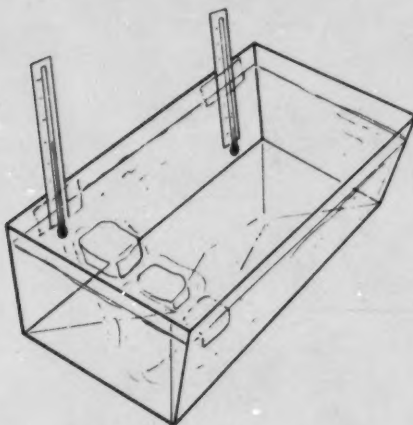


Figure 1. Shoe box set-up to show the presence of a cold layer of water.

Have students predict which thermometer will show the lower temperature when ice cubes are placed at the end of the box with the thermometer near the water's surface. Put the ice cubes in place so they form a row, but keep them about one inch from the bulb of the thermometer.

Students should read the thermometers after waiting a few minutes. While waiting, you might discuss the reasons behind individual predictions. Several readings should be recorded. Many students will be surprised that a colder reading was obtained at the bottom of the far end of the box.

Discuss:

1. How might their observations be explained?
2. How might we make the movement of the water visible (place drops of food coloring below the ice cubes with a medicine dropper)?
3. Personal experiences or observations where cooler water was beneath warmer.
4. Why does ice float but "cold" water sink?
5. Where are similar movements taking place with substances other than water (any fluid--i.e., liquid or gas--such as air)?

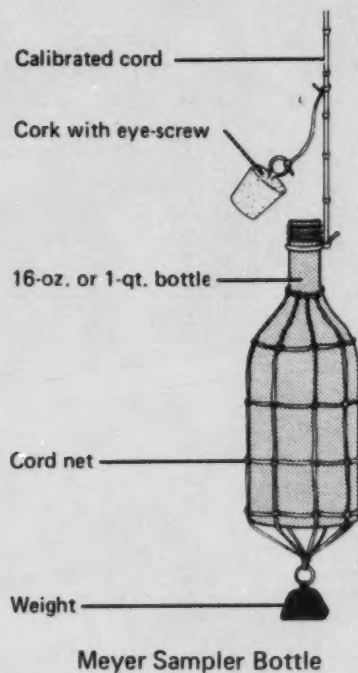
With few modifications, this activity can be done in small aquaria. If the aquarium is in use, fish, snails, or other living organisms can be observed reacting to the temperature change. The possibility of harming some organisms, however, does exist.

ACTIVITY VI

Purpose: To develop the skill necessary to determine water temperature. To provide data from field studies relative to classroom demonstrations and theory.

Materials:

1. Laboratory thermometer
2. Rope or cord calibrated by placing marks ten centimeters apart
3. A "Meyer Sampler" (Figure 2) requiring:
 - a. A one quart bottle
 - b. Cork with eye screw
 - c. Cord net or some device to hold a weight
 - d. Weight



Procedure: When measuring temperature:

1. Shade the thermometer from the direct rays of the sun.
2. Completely immerse the bulb of the thermometer in the water.

3. Let the bulb of the thermometer remain in the water long enough for it to come to the same temperature as the water. The thermometer should be read while in the water.

The exact procedures for determining water temperature will vary with the body of water. Surface temperatures are obtained by merely immersing the bulb of the thermometer in the lake or stream. For measurements at greater depths, the "Meyer Sampler" method is recommended. It is easily made from the materials listed and with proper use, water may be brought to the surface with little change in water temperature. The weighted bottle filled with air is lowered to the desired depth with the cork in place. The attached weight should be great enough to sink the air-filled bottle but not pull the cork until the calibrated line is jerked. After jerking the cork out and waiting a few minutes for the bottle to fill, the water sample is brought to the surface and its temperature measured as soon as possible.

To obtain the most reliable data:

1. Take a number of readings at each depth and determine an average.
2. Consider the time of day and year when making comparisons.
3. Consider those factors such as precipitation and the location of streams, pipes, or ditches.

It is possible for temperature readings in a pond or lake to provide data to investigate thermal stratification and in longer field studies, the events of water turnover with the seasons.

ACTIVITY VII

Purpose: To determine the degree of light penetration (transparency) in streams and lakes. To relate the degree of light penetration to zones of photosynthetic production. To estimate the extent of the latorral and limnetic zones. To obtain an estimate of suspended material (turbidity).

Materials:

1. A metal disc 15 to 25 cm. in diameter divided into four quarters with two opposite quarters white and two black (Secchi Disc)
2. A calibrated line

Procedure: Lower the disc into the water until it just disappears and check the calibrated line for depth. Then raise the disc until sighted and determine depth. Average the two measures. The process should be repeated three times to determine an overall average. Better readings may be made if the disc is observed through a glass-bottomed container which reduces reflection. If the reading is low (several feet), the water is considered as having considerable suspended material. To determine turbidity where the water is shallow and the disc touches bottom before disappearing, a vertical measure may be replaced by a horizontal measure using a mirror. The mirror, attached to a stick at a 45° angle, is aligned with a string running from the Secchi disc to the mirror (Figure 3). The distance from the water surface to the mirror is added to the distance between the mirror and the disc to obtain an indication of turbidity. Recording procedure is similar to the horizontal measure.



Figure 1. Measuring turbidity in shallow water.

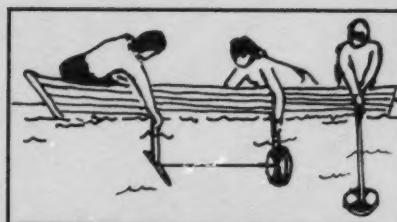


Figure 2. Comparing horizontal and vertical measurements from a floating dock.

The Secchi disc provides the student with an estimate of the horizontal depth of the littoral and limnetic zones in a pond or lake (trophogenic zone) since photosynthesis cannot take place where the light does not penetrate.

In a pond or lake study, the disc can also provide data on the distribution of suspended particles. Have students determine vertical and horizontal Secchi disc readings in the same area of a pond or lake. Questions might include:

- A. What assumptions might be made if vertical and horizontal Secchi disc readings are:
 1. Equal?
 2. Vertical greater than horizontal?
 3. Horizontal greater than vertical?

Assumptions:

- A. In the case when readings are equal, we have uniform distribution of particles. If the vertical measure is greater than the horizontal, then surface water has greater concentration of suspended particles. Where the vertical measure is less than the horizontal, then surface waters have a lesser concentration of suspended particles than deeper water.
- B. What kind of vertical-horizontal Secchi disc readings might you expect after a rain has washed silt into a pond?
- C. In a pond during late summer, would you predict the greatest suspension of particles to be at higher or lower depths? What kind of particles might you find? Why?
- D. A pond is filled with suspended material which allows light to penetrate a few inches. What would you predict might happen to the depth of the trophogenic zone?

ACTIVITY VIII

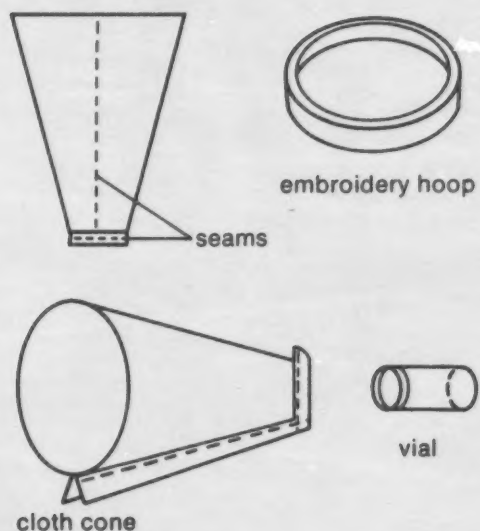
Purpose: To explore the number and kinds of living things in the waters of a pond, lake, or stream (or any ditch or hole in the ground). To introduce the concept that all organisms are interrelated. To introduce field study techniques and procedures.

Materials: (For each team)

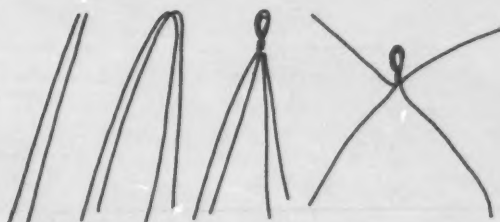
1. Pond Guide (Golden Press)
2. 3" X 5" cards and marking pens or crayons
3. String
4. Three baby food jars--one for use as vial in the plankton net
5. Three small white containers--styrofoam cups
6. One shallow, white-bottomed container--dish pan
7. Two boundary markers
8. One white plastic spoon
9. Two hand lenses
10. Two medicine droppers
11. One basting syringe
12. Two dip nets--use coat hanger and nylon stocking
13. One plankton net--a serviceable net for collecting concentrations of minute aquatic organisms can be made with:
 - a. One plastic embroidery hoop--15 cm. in diameter
 - b. One piece of old bedsheet
 - c. One small baby food jar
 - d. Two pieces of soft wire 10 cm. longer than the diameter of the embroidery hoop
 - e. One six meter nylon tow line

Directions:

1. Sew the cloth cone. The net is a cone of old bed sheet material as wide at the top as your embroidery hoop, and as narrow at the bottom as your vial. A couple of measurements and a trial or two should be sufficient to give a suitable pattern from which any number of nets can be made. Two seams are needed: one at the vial end to keep the material from unraveling, and one up the side to make a cone.

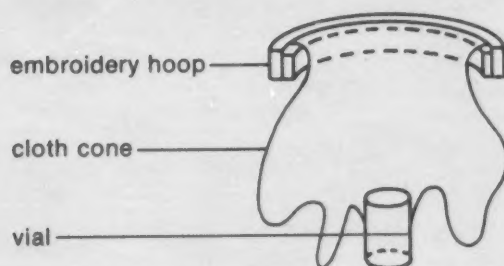


2. Prepare the wire yoke. Using a pair of pliers, if necessary, twist the two wires together as shown. Be sure to leave an eye at the center to attach your tow line.

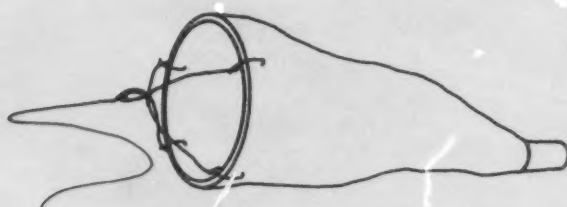


3. Assemble your net. Fix the net in the embroidery hoop. Any way that will work is good, but this way is the best:

Cross-section of Plankton Net



Attach the wire hoke to the hoop-net combination by pushing the wire through the cloth and twisting each wire around the hoop.



Drop the vial in from the open end and secure it with a rubber band. Attach a tow line to the eye of the yoke, and your net is ready.

4. To use a plankton net, toss it underhand into the water and either pull it in hand-over-hand, or pull it out by moving away from the pond. Make five or more passes to concentrate the surface life before examining the plastic holding vial. Tie a loose loop around the end of the tow line for the student's hand to fit through. This prevents loss of numerous plankton nets.

Procedure: For a successful field activity of this type, a site should be selected that has fairly shallow water with gently sloping banks. An unobstructed view allows for both easy supervision and a chance for the student to see the body of water relative to the surrounding watershed. The site should be visited prior to the field trip. Check for electric fences, poison ivy, cattle, etc. There is nothing worse than arriving at a previously selected site to find a herd of cows wallowing in the only place your students could work.

Before exploring the site, discuss how the group can study the area without harming the living things and their environment. A good policy is to agree that the study area will be left (as

much as possible) like you found it. Organisms should be studied and returned unharmed to their source.

Divide the group into teams of two using the "buddy" system so members may assist one another. Before getting their equipment, each team should mark off the shoreline they will study. At their site, have the teams sit quietly at the shore and observe all they can. Remind them to look for the smaller as well as the larger objects.

Considering the age and experience of the student, demonstrate the use of the thermometer, hand lens, microscope, eye dropper, pond guides, plankton nets, etc. For younger children it may be appropriate to explain that the white bottomed containers carrying samples from the plankton net, etc., should be set on the ground and allowed to settle. Small organisms in motion can be seen better this way.

A good beginning activity is to direct the students to observe the life forms living underneath and on the bottom of small stones and rocks found in shallow water by the shore. Vegetation along the shore and other organisms living on it may be dragged in using a short stick. Holding both rocks and vegetation in the sunlight for a short period will often reveal a number of different organisms.

Suggest using a pond guide for reference and have each team write the name of plants and animals they find on 3" X 5" cards with one name written in large print with crayon or ink marker on each card. Collect the cards, remove duplicates, and add cards labeled "Air, Sun, Soil, Tree, Rock, Water," etc. Be sure to include "Sun" in the set. Have about ten students sit in a circle, each with a card held out in front of him so it can be read by everyone. Each student now represents some animal, plant, or environmental factor. Place the end of a long string in the hand of one student (algae) and ask him to send a strand of string to another student (sun) of his choice and explain how they are dependent on each other. A strand is then sent to another organism or environmental factor such as algae to water, water to frog, frog to insect, with an interrelationship expressed by the student for each strand. Continue until each student participates, i.e., all factors are considered. Then cut any strand. Gather in the string while discussing

the effects of the "break" between the two organisms on each of the other organisms. Relate the visual "web" of string to the "web of life" where all life forms are interrelated.

Small organisms seen with the naked eye can be captured and observed with the aid of a medicine dropper and hand lens. Once in the eye dropper, their motion is restricted and you can get a close look with a hand lens. A good way to capture larger organisms is to employ a baster used in cooking. If microscopes are available, the captured organism can be placed on a slide for observation. Microscopes should be placed on level, solid ground, boxes, or a portable table. Keep samples of all organisms in small white containers for easy viewing and provide time for them to be observed by all students.

Have the students determine:

1. How many different plants and animals were found?
2. Which plant and which animal was most abundant?
3. Which plant and which animal was least abundant?
4. Who found a plant or animal that nobody else found?
5. Is the lake, stream, or pond richly or poorly populated with living things?
6. Where does the water come from?
7. How does it leave? Where does it go?
8. How do you feel about water? What makes water nicer?
9. If one kind of organism disappeared, who (or what) might go hungry?

ACTIVITY IX

Purpose: To compare the process of natural recycling of dead vegetation in different types of containers placed in an aquatic environment. To demonstrate the concept of biodegradable and non-biodegradable materials.

Materials: (For each student)

1. Leafy vegetables, potatoes, carrots, or other plant materials from the grocer's garbage can. Fresh grass will work. Don't use leaves as it takes too long for them to decay.
2. One nylon stocking
3. One large-mesh plastic or nylon bag
4. One plastic bag without holes
5. One wooden stake
6. One pencil
7. One data chart

DATA CHART					
Container	Weight			Appearance of Bag & Contents	
	Before	After	Difference	Before	After
Nylon stocking & dead veg.					
Mesh bag & dead veg.					
Plastic bag - no holes & dead veg.					

Materials: (For the group)

1. Scales
2. Ball of nylon string

Procedure: (This activity requires one to eight weeks)
Distribute the Data Chart and three different bags to each student.

Discuss the following instructions; then have students write them on the back of their Data Chart:

- a. Put some of each vegetable into each of the three bags.
- b. Make and record observations of the vegetable into each of the three bags.
- c. Close and tie the bags tightly, leaving some extra string to tie the bag to a stake.
- d. Dip each bag in water. Remove and allow them to drip one minute--then weigh and record weight on Data Chart.
- e. At some convenient aquatic habitat (pond, lake, stream), have each student attach their bags to the stake. Firmly fix the stake so it holds all three bags under water.
- f. Retrieve the three bags one to eight weeks later. Allow them to drip for one minute--then weigh each bag and record weight on the Data Chart.
- g. Open each bag--observe the contents and record the appearance of the contents on the Data Chart.
- h. Compare the contents in each of the three bags. Compare the contents in the bags of other students.

Questions:

1. Can you explain the changes in the vegetation contained in each bag?
2. What might the kind of bag have to do with the changes?
3. What would happen if vegetation did not decompose?
4. What would happen if a truckload of vegetation were dumped in a very small pond?
5. Where do the green plants in a pond go each winter?

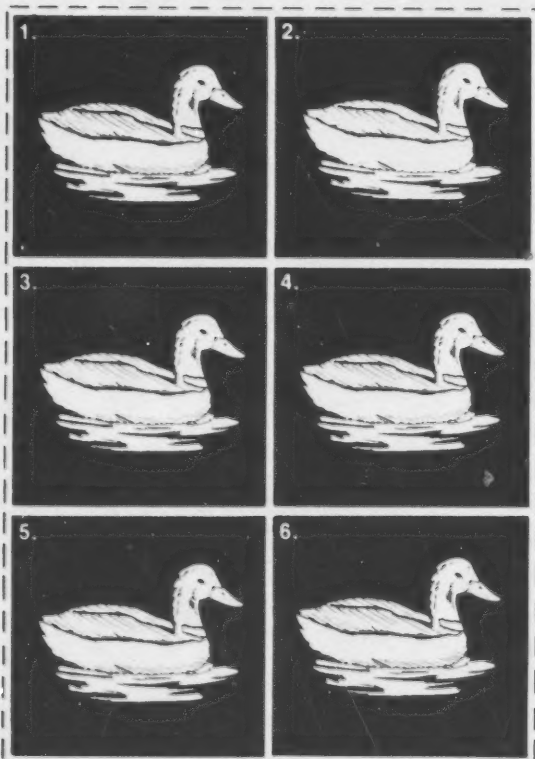
DUCK GAME

There are several duck nests near the pond. Each nest produced six ducklings. The ducklings must get to the water and find food and shelter to live. There are many dangers in the lives of ducks.

DIRECTIONS

1. Use one spinner and a playing token for each player. Insert pencil in spinner as shown.
2. Put players' names on score sheet below.
3. Player with token No. 1 spins first. Side which lands on table shows number of spaces to move.
4. Player must follow directions on step which token lands on. The player may go either way around the pond when the token lands on the step labeled "Caution: Snapping Turtle."
5. Each time a player loses a duck, cross out one duck on score sheet after that player's name. A player who loses all six ducks must drop out of the game.
6. Continue playing until all players have reached FINISH. **Player finishing with most surviving ducks is the WINNER.** If two players have the same number of ducks left, the one who got to FINISH first is the WINNER.

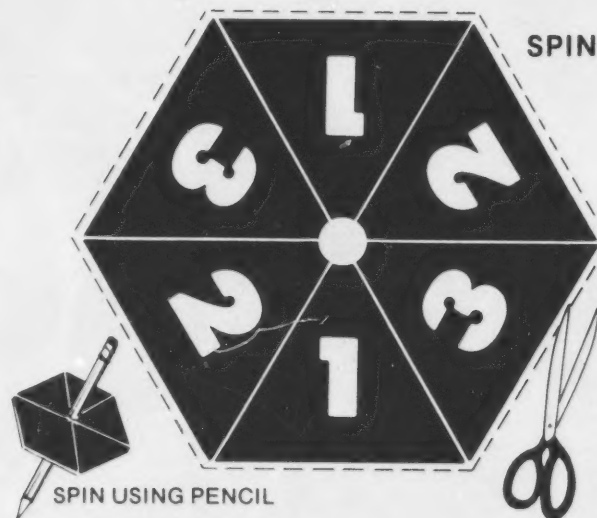
PLAYER TOKENS



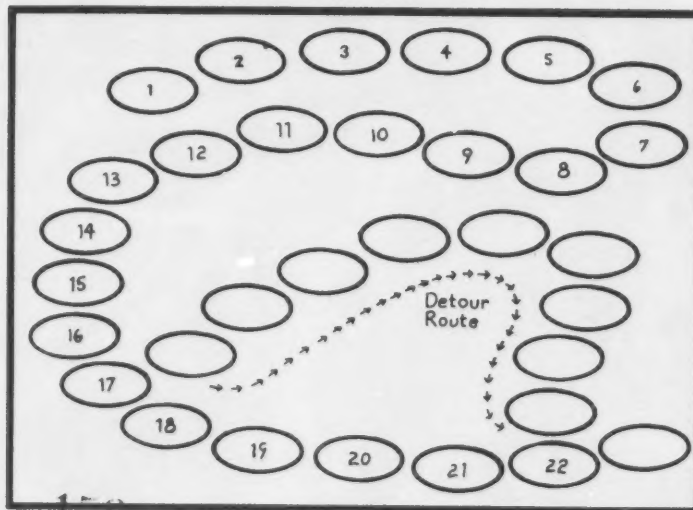
SCORE SHEET

Name	Number of Ducks						Total Surviving Ducks
	1	2	3	4	5	6	
1.							
2.							
3.							
4.							
5.							
6.							

SPINNER



GAME BOARD PLAN



GAME SITUATION STATEMENTS



1.
START

2.
Soon after the ducklings hatch, a house cat finds the nest and takes one duckling before the mother duck scares it away. **Cross out one duckling.**

3.
Blank space.

4.
Tall grass protects the mother duck and ducklings on their way to the pond. **Move ahead 2 spaces.**

5.
Blank space.

6.
Blank space.

7.
The pond has been drained for crops; they must find another pond. **Go back to start.**

8.
Blank space.

9.
Two ducklings are chased and caught by a boy and girl and taken home. **Cross out 2 ducklings.**

10.
The weather is cold and wet for several days; not many insects are hatching. **Go back 2 spaces.**

11.
There are many insects for the ducklings to eat. **Move ahead 2 spaces.**

12.
Blank space.

13.
Blank space.

14.
Spraying for mosquitos kills many insects. **Move back 2 spaces.**

15.
Blank space.

16.
Blank space.

17.
Danger Route
Caution: snapping turtle ahead take a chance or detour
Move ahead 1 space

18.
Blank space.

19.
Blank space.

20.
Eaten by a large snapping turtle which lives in the pond. **Cross out 1 duckling.**

21.
Blank space.

22.
A grass fire burns some of the cattails on the edge of the pond. **Move back 1 space.**

FINISH

Detour

Detour

Detour

Detour
Cattails and other plants in the pond protect the ducklings. **Move ahead 1 space.**

Detour

Detour

Detour

Detour

Detour

CHAPTER III - HABITAT AND WILDLIFE

No Place For Wildlife

Oklahoma's economy, and he who says they cause habitat loss attracts as much attention as a sheepherder at branding time. Until recently, there has been an almost-steady increase in cattle produced and their market value.

Comparing the days of the Chisolm trail to figures unearthed for 1971, we find Oklahoma cowboys once drove fewer than a million head when our tall-grass prairie still had tall grass on it. Those cattle had a total market value of slightly more than \$11 million. The more modern cowpokes of 1971 herded more than five million little dogies, representing a market price of just over \$800 million.

A six-fold increase in cattle at a 75-fold jump in value looks like Hereford heaven on earth to the layman. Realistic figuring shows inflation has made this activity less lucrative in recent years. In fact, it hasn't been too long since cattlemen boycotted the market, rather than sell at a loss. There simply were too many cows. However, we have too long been accustomed to red meat to let this go on. We will continue to worship

the golden calf, and cattlemen will raise beef according to public demand.

The big increase in cattle has brought a big problem, since it was followed by an increase in over-grazed acres. A Soil Conservation Service inventory admits, since 1965 the number of properly grazed acres has been going down steadily. That is a polite way of saying while "only" 60 percent of Oklahoma was overgrazed in 1965, 82.5 percent had been chomped to the roots by 1971. There may not be any more land being made, but there are still plenty of grazers being produced to dwell on it.

Some other interesting changes in the land have appeared since statehood. The number of farms has dropped, by a margin of 43 percent since 1934. However, the average size of each farm has increased almost 60 percent. It should surprise no one who has tried to purchase an acreage that the value of our agricultural land rose 100-fold between 1939 and 1969, from \$6 million to \$600 million!

Oklahoma's population has gone up, too; from a little more than a million people in the 19-teens to more than 2.5 million in the 1970 census. From the turn of the century to 1969, these people moved into a land area that decreased about 9/10 of one percent, some 404 million acres. Urban sprawl ate up seven percent of the state between 1958 and 1967. Ponds

and large impoundments for water supply, flood control and hydroelectric power have taken their toll, as have road construction and housing.

National population studies have shown a reversing of the rural-to-urban movement of a few years ago. Man's competitive drive to earn more, so that his loved ones could live better, once lured him to city jobs. Now, urban man realizes he needs wild and quiet places in which to rest his nerves. So, he spreads outward, commuting between the good life and the wood life. In seeking to better know the wildflowers, he tramples many underfoot.

Future directions can be mapped as land uses change to meet our growing needs. We are in competition with nature for the right to survive. We view that right as being without obligation to the land that nurtures us. Man rolls sevens and wildlife gets snake-eyes.

Much of our grassland habitat will continue to disappear under Oklahoma wheat. The rest of what was once "home, sweet home" to wildlife will be sown to such domestic hays as alfalfa. Native grasses will become memories and Oklahoma trees will fall faster than deer, turkey and squirrels can get out of the way. In short, these natural resources shall continue towards a rendezvous with the passenger pigeon.

Future sportsmen will be reduced to seeking non-existent bobwhites in a countryside which has been

turned into one, big, Bermuda grass pasture. Farmers and ranchers are not the villains in this crystal ball view. They've only responded in a business-like way to a growing public demand for more and better food.

"Everyman" is the reason our land and wildlife are being sacrificed. It makes no difference whether his taste runs to prime rib at a fine restaurant or a quick burger at the local convenience-food store, he continues to demand more bread and more meat. Each of us is everyman; you and I place less value on a quality outdoors than on our daily protein.

Increasing pasturelands never will keep pace with our growing demand for beefsteak. Man's burgeoning population is straining our agricultural technocracy. Oklahoma will continue to reflect world growth by more than doubling its population in a short time. The crying need for agricultural goods has forced a new efficiency upon the farmer/rancher, eliminating small operations. Tight farm economy and foreign demands for our crops have pushed the plow out to meet the county road. For the price of a covey of Oklahoma quail, the world gains another box of "Country Blessings" natural cereal.

Wildlife management is one of man's more sage endeavors. We have learned what is needed to control wild species and how to provide it. Unfortunately, we may have learned too late that the same principles

apply to people. We run the risk of someday discovering we are a part of the natural world, rather than the sole reason for its existence.

When that day comes, anthropologists will change the name of man, the competitor, to man, the steward. Until then, we go about our business of eliminating the competition. If that course continues, the earth's last inhabitant might be a lonely, two-legged exotic.

"The ecologist should be able to show that it is just as much fun and just as important to repair the biosphere and keep it in good running order as to mend the radio or the family car." (Hutchison)

Any area of nature that includes living organisms and nonliving substances interacting to produce an exchange of materials between the living and nonliving parts is an ecological system or ecosystem. (Tansley)

The ecosystem has been conveniently divided into four parts:

1. Nonliving, abiotic substances -- basic organic and inorganic compounds of the environment;
2. Producers -- mostly green plants which are able to manufacture food from simple inorganic substances;
3. Consumers -- mainly animals who eat other organisms or organic matter; and
4. Decomposers -- organisms known to break down the complex compound of dead organisms, absorb some of the decomposed products and release simple substances useful to the producers, mainly bacteria and fungi.

The ecosystem is the basic functional unit in ecology and it includes all living and nonliving things. A lake is an example of an ecosystem. In it there is a circular pattern of events whereby natural materials are circulated repeatedly within the environment. This pattern constitutes the cycling of abiotic materials to producers, consumers and decomposers. Living things (organisms), both plants and animals, will live in this environment and occupy a place and perform some role.

The term habitat is widely used, not only in ecology, but in societies also. It is generally understood to mean simply the place where an organism lives or where you would go to find it. The ecological niche is the status or position of an organism within its habitat, community and ecosystem resulting from what the organism has inherited and/or learned. Habitat may also refer to the place where an entire community lives, plus all of the nonliving objects of the environment; therefore, the word habitat, as used in a language, could have at least two possible uses.

In order to really become acquainted with an organism in a habitat, you first need to know where it can be found, and more than just the surroundings -- where it lives and works. You want to know something about its occupation, interests, associates and the part it plays in general community life. In order to determine the organism's status or niche, you would need to know

something of its activities and particularly its nutrition and energy source. The growth rate of an organism effects all other organisms with which it comes into contact and the surroundings it occupies.

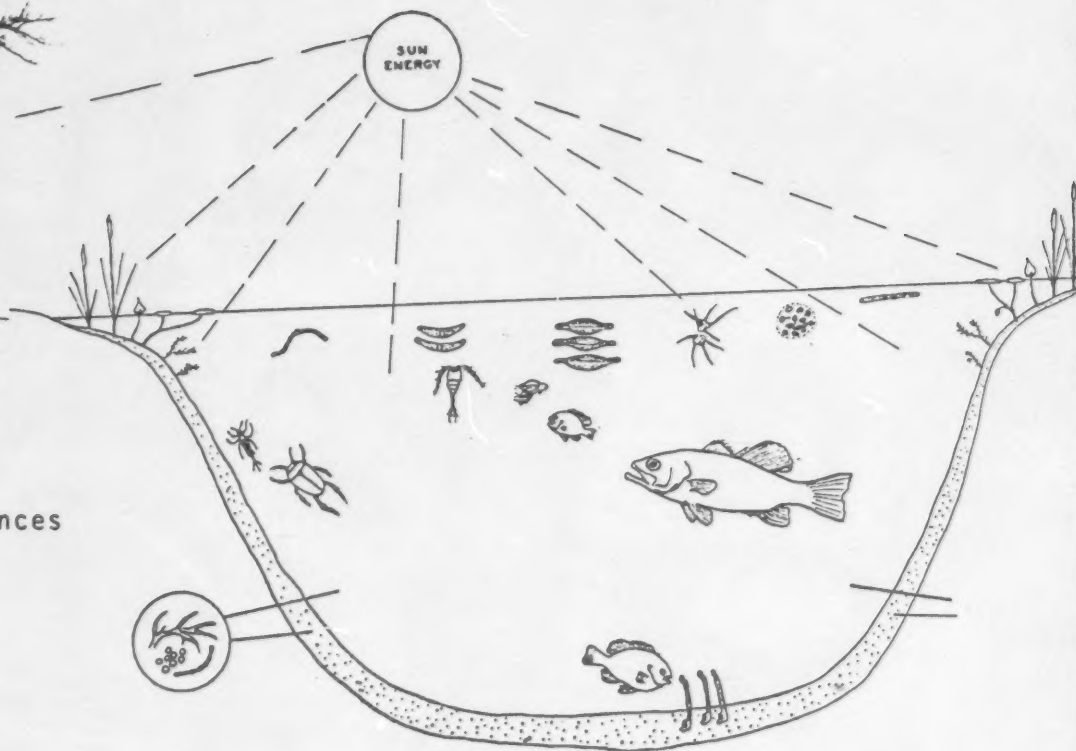
If you want to "collect" an organism, the fact that you know the habitat is not enough, nor is knowing the niche of the organism enough to go find it, because very rarely do any two organisms that are the same area occupy the same niche. In laboratories or other confined places, you can observe certain things about an organism relative to its habitat and niche; however, for better results, you most certainly would have to observe and experiment in nature.



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IDENTIFY

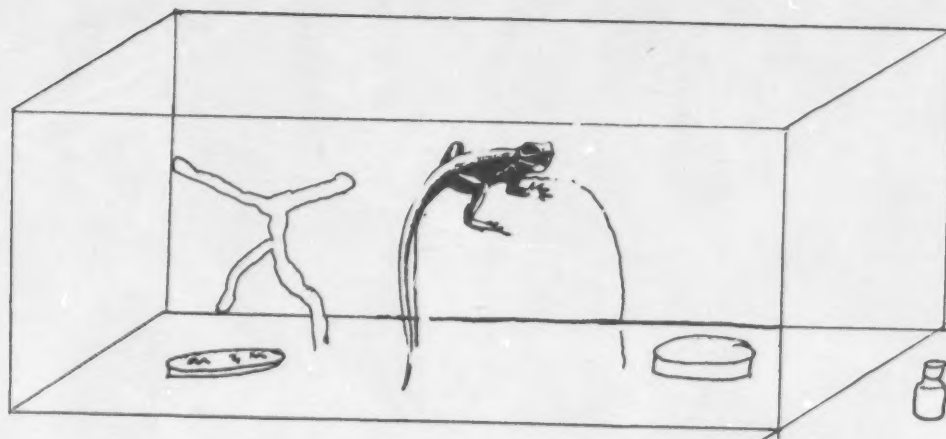
1. Nonliving (abiotic) substances
2. Producers
3. Consumers
4. Decomposers



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ILLUSTRATION B



MATERIALS: Terrarium, food and water dish, rocks, limb, mealworms, nontoxic animal paints, chameleons

Mark eight chameleons with animal paint so that each can be recognized by a color or spot position. Place the chameleons in the terrarium and begin a daily record of the position or resting place upon which a specific chameleon sets. Continue recording each resting place until you do not observe any changes. Does one chameleon appear to dominate the others by position? Place several mealworms in the food dish; observe and record the feeding habits. Does one chameleon appear to be first to eat each time?

An article by Mickey Brown in the Outdoor Oklahoma Conservation Notebook describes Oklahoma's habitat.

"Habitat" is a word conservationists use to mean an animal's home. An animal's habitat is like your house, neighborhood, school and town. But it is more than this. You have certain basic requirements which your habitat must provide, and the same is true for animals. People and animals are very similar in their physical needs, and neither can live in habitats which do not meet these needs.

All animals, including man, need food, water and cover. While man can modify his habitat to make it provide these elements, most animals cannot. How well a habitat supplies these needs determines how many animals can live there. We call this the limiting factor, because wildlife numbers are determined by the available habitat.

Food is necessary for any form of life. Without it neither man nor animals can survive. The more variety there is in an area's food, the more kinds of wild animals will make it their home.

The second element of good habitat, water, is essential to most forms of wildlife. The kind and amount of water needed varies with the species, but all animals need water, because it supports additional vegetation for food or cover.

Cover, which is like your home, can be any material that gives wildlife a place to hide, a place where enemies cannot follow or a place that offers shelter from the weather. It might be a patch of grass for a quail, a brushpile or thicket for a rabbit or a forest for a herd of deer. Whatever the cover type, it must be thick enough to hide the animal and heavy enough for protection from winter storms. Good cover is preferred as a place to build nests or dens because it means protection for the young. The presence of cover also means that the soil will not wash away and the water will not become muddy. Quite often, cover is also the main source of wildlife food.

A variety of cover provides different kinds of food for animals as they grow older and their eating habits change. Variety is also important because different plants produce food in different seasons. In this way, cover can provide food all year long.

For any kind of food to be of value to wildlife, it should be where the animals feel safe while they are feeding. This, too, differs with the species. Some animals rely on keen eyesight and speed to escape from enemies and are satisfied to find their food out in the open. Small animals usually prefer that the food be where predators cannot find them. This means that they must have a source of food that is in or very near escape cover.

Different types of cover meet the requirements of different animals, each of which may need a variety during the year. For example, quail are satisfied with grass and weeds for summer nesting cover, but winter means quail must find thicker cover that gives protection from the weather and offers a hiding place when the leaves are gone. Winter is the hardest time of year for all animals, and the presence of den trees for squirrels and raccoons, brushpiles for rabbits and dense thickets for quail and turkey can be the factor that determines their survival.

Habitat is called the critical factor for wildlife because it determines if their basic needs are met. Two different types of cover may support the same animal, but the numbers and relative size of that animal may be very different. For example, southeastern Oklahoma has many deer, due mostly to the quantity of vegetation in this area.

The northwestern part of the state has fewer deer, but these are usually larger, due to the higher nutrient quality of the vegetation. There are many factors which affect the quantity and quality of cover, such as different soil types, altitude, rainfall and temperature ranges. The size and number of wild animals is controlled by this difference in vegetative quality and quantity.

Man's use of the land changes the vegetation and results in changes in its value as cover. Almost all

wildlife is affected by such changes. It is not hunting but the needless destruction of habitat that is the major threat to wildlife in Oklahoma. This loss of habitat is becoming more critical each year.

Such changes have quicker and more noticeable effects on animals with high rates of reproduction, such as quail, doves and rabbits. If their favorite cover is destroyed, they will disappear very quickly. However, these animals will also recover rapidly from such setbacks, and they have a normal rise and fall in their populations depending on habitat conditions.

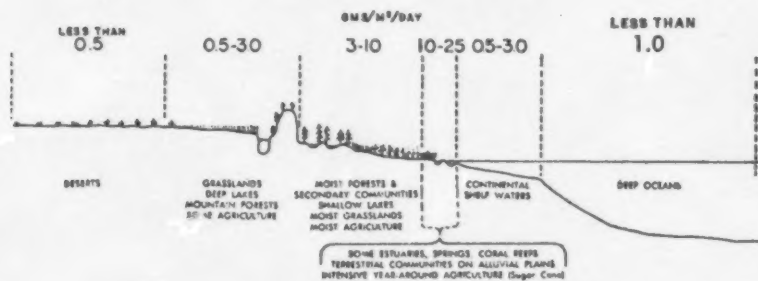
In too many areas forests are permanently cleared, roadsides and ditches are burned each year and woodlots and odd corners are continually grazed. To help save this vanishing cover, the Oklahoma Department of Wildlife Conservation started the "Acres for Wildlife" program. By setting aside plots of land of at least one acre in size, better wildlife habitat can be developed through the return of natural growth. This regrowth is insured if the plots are not mowed, burned, grazed or sprayed in any manner harmful to wildlife for a period of at least one year.

Allowing areas to grow naturally often insures that both man and wildlife can have productive futures. Nature, with a little understanding and tolerance from man, will be able to provide wildlife's habitat needs for food, water and cover.

The wildlife habitat must include food, water and shelter for survival. In becoming acquainted with the basic needs, attention should be focused on a "first-hand" examination of each specific need, which should be followed with a study of the interactions of these needs. Illustration C provides a reasonable estimate of the range of gross productivity found in basic types of ecosystems of the world. Observe the similarity of the productivity of oceans and land deserts. Both are low, but the limiting factors of each are quite different (nutrients in ocean; water on land), and the organisms are different (algae instead of spermatophytes), so that the two places are similar-type "deserts".

Production rates in excess of 20 grams are being reported today where intensive agriculture exists. It is doubtful that any extensive ecosystem can maintain a rate higher than 25 gms/M²/day for periods of years. What is a reasonable productive rate? What are the factors limiting long-range intensive agriculture?

ILLUSTRATION C



The biotic, living, communities are conveniently identified and classified according to: (1) major structural features such as dominant species, life forms, or indicators; (2) the physical habitat of the community; and (3) functional attributes such as the type of community species interaction. Names for communities lending to classifying the ecosystem are based on structural features and functional attributes. There are three major habitats of the living environment; namely, marine, fresh-water and terrestrial. A more detailed discussion of these major habitats is found in other chapters.

The major biotic (living) communities are:

Tundra - Any of the vast, nearly level, treeless plains of the arctic region; includes mooses, forbes, sages.

Northern Conifer Forest (Tiaga) - Forests of arctic, subarctic regions having a very low productive level for both plant and animal life.

Temperate Deciduous and Rain Forest - A region of high productivity in the middle to low latitudes.

Temperate Grasslands - A region of tall and short grasses of the mid latitudes; usually low rainfall.

Chaparral - An almost desert or semidesert area that supports scrub trees, brush-type instead of grass.

Desert - A region of very low rainfall, low productivity of grasses; usually sparsely populated by animals.

Tropical Rain Forest - A hot, sultry, very moist, torrid region of fast plant growth; in low latitudes.

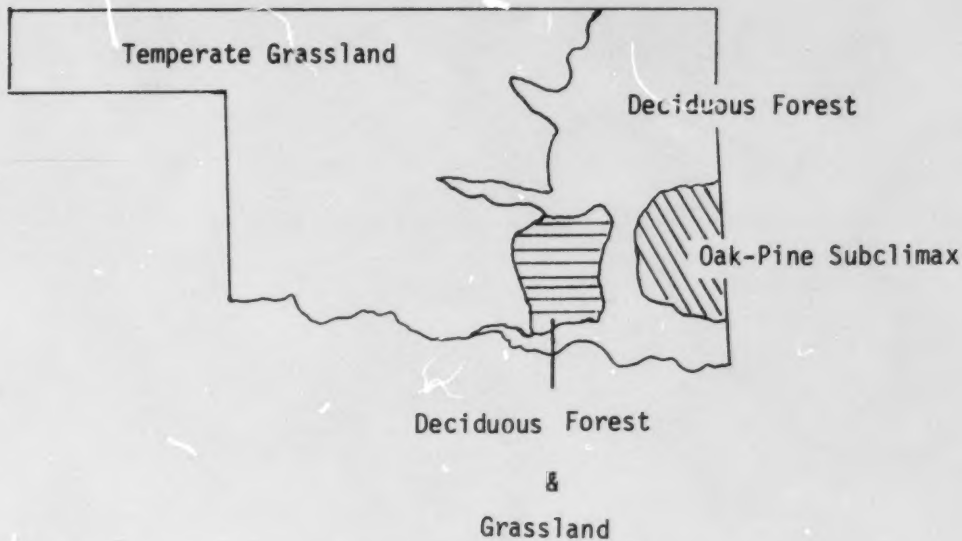
Tropical Deciduous Forest - A region dominated by hard woods; a hot, sultry and moist zone.

Tropical Scrub Forest - A moist zone dominated by low-growing scrub and shrub plants.

Tropical Grassland and Savanna - A region of adequate rainfall to support grasses and spots of trees.

Mountains - A region of complex zonation determined basically by latitude and altitude.

The two major biomes of Oklahoma are the temperate grasslands and the temperate deciduous and rain forest.



The pivotal problem in preserving wildlife is maintaining an environment that provides food, water and shelter against natural enemies. This is both a qualitative and a quantitative problem. Breeding and rearing areas are critical. Without suitable places to build their nests and rear their young, the population of a species is soon diminished. If animals can find ways to protect their eggs or young, the population of the species will be maintained, or may even increase. Rachel Carson related a life and death struggle in her book Under the Sea-Wind.

"The scent of terrapin and of terrapin eggs, fresh laid, was heavy in the air. Snuffling and squeaking in excitement, the rat began to dig and in a few minutes had uncovered an egg, had pierced the shell, and sucked out the yolk. He then uncovered two other eggs and might have eaten them if he had not heard a movement in a near-by clump of marsh grass--the scrambling of a young terrapin struggling to escape the water that was seeping up around its tussock of tangled roots and mud. A dark form moved across the sand and through the rivulet of water. The rat seized the baby terrapin and carried it in his teeth through the marsh grasses to a hummock of higher ground. Engrossed in gnawing away the thin shell of the terrapin, he did not notice how the tide was creeping up about him and running deeper around the hummock. It was thus that the blue heron, wading back around the shore of the island, came upon the rat and speared him."

Wildlife is inescapably linked to the natural health of the land. The close web of interrelations that exists in the environment is easily broken. The loss of a single species, which may at first appear to

be of little importance, is often the beginning of a chain reaction that eventually affects many species. There is a close relationship between epidemics and the absence of predatory animals or parasites. Clean farming and clean forestry, while pleasing to the eye and in keeping with an acquired sense of order, eliminate and destroy the dead trees, the plant litter, and the webs of tangled vines and undergrowth that are essential for the nesting or hibernation of wildlife. The destruction of certain kinds of weeds may cause insects to transfer their attacks to economically important crops. These are but a few of the many examples of changes in environment that may have lasting effects on plant and animal life. Land that is used for intensive crop production is, of course, not maintained in a natural condition; but the interplay of natural forces essential in a healthy climate for wildlife and plant growth can be maintained on land that is managed for game, recreation and related purposes.

Conservation practices sponsored by the soil conservation districts--stripcropping, contour cultivation, proper irrigation, crop rotation, stubble mulching, grassed waterways, improved pastures, better range management, farm and ranch ponds, windbreaks, and other control measures--have provided food and cover for wildlife.

At the present time, there is a greater number of game birds, furbearers and other game animals, and fish in the United States than when the white man first set foot on American soil. With present soil and water conservation practices, the number will continue to grow, even with an increase in hunting and fishing. The wildlife population over the years has changed. In the place of the passenger pigeon, heath hen and bison, there are now pheasants, turkeys, prairie chickens, and a larger deer population. Planted fence rows, windbreaks, shelterbelts and other conservation plantings provide food and cover for this game. Farmers have constructed more than a million farm ponds which provide water for big game, furbearers and migrating waterfowl, in addition to bass, channel catfish, bluegills and other game fish.

Wildlife and wildlife management are the responsibility of individuals, families, communities, states and the nation. Wildlife management cannot be separated from the social issues of industrialism, big business and the increase in urban population. Conceivably, wildlife could have no place in which to run or grow. Its food, water and shelter are endangered without applying good, futuristic management practices today.

The greatest single factor affecting the continuity of wildlife is improving the habitat; that, together with continued control of wildlife harvest, offers the greatest opportunity for perpetuating the wildlife resources.

In the January, 1973 issue of Outdoor Oklahoma, Ron Krajnovich describes how to develop acreage for wildlife production in an article on Habitat Improvement.

Over the past half century several methods have been developed to increase wildlife populations. At first it was felt that killing predators was the answer to having more game and wildlife in general. Unfortunately, few people understood that predation was merely nature's way of controlling populations. By removing crippled and diseased individuals, predators helped assure healthy wildlife populations. Since prey species multiply much faster than predators, their numbers were actually the major controlling factor in the size of predator populations.

Man, a sophisticated predator, was controlled through the establishment of bag limits, season lengths and often, a complete ban on hunting. In many cases these regulations helped curb the decline in numbers of several endangered species. Still, there just never seemed to be any significant increase in the numbers of most species, regardless of whether they were hunted or not.

Restocking was even tried to supplement some important game species. The release of pen-raised birds and animals did not produce the desired increases in most cases for the simple reason that there was no place for them to go.

With the continual advance of human habitation and its accompanying clearing, farming and grazing practices, there have been alarming losses in natural habitat. The loss of wildlife goes hand in hand with the loss of habitat.

Why is habitat the critical factor? Because it supplies life's basic requirements of food, water, living space and protection from weather and enemies. These four essential needs of all living creatures must occur together wherever animals live.

To supply these essentials on your land for the encouragement of wildlife, you should initiate a habitat improvement program directed at the specific conditions existing there. No matter what particular variables influence your development project, all must satisfy the fundamentals . . . cover, food, water and living space.

Cover

Cover is any material that protects wildlife by providing concealment, hampers an enemy's pursuit or affords shelter from the weather. It might be a brush-pile den for a cottontail, a forest for a herd of deer or a patch of native grasses for a pair of nesting quail.

Different species have different cover requirements, and each may need several varieties for a multitude of activities. The bobwhite, for example, can use annual grasses or weeds for summer nesting cover, but for winter

protection needs durable vegetation that resists weather and offers concealment when summer foliage is gone.

An important aspect of cover is the "edge" or transitional zone between woods and meadow. This zone, with its wide variety of plant types, supports more wildlife than any other habitat situation.

Numbers of wildlife on most land can be increased by increasing the amount of "edge." In heavy woods, selective clearing is probably the answer. Dense, mature timberlands seldom offer much to most wildlife species. However, some mature mast-bearing and den trees should be left for squirrels, raccoons and wood ducks.

To encourage more use it is necessary to make openings in established stands to provide a greater variety of food and cover plants, better nesting sites and more feeding places for young broods. These openings can be any shape and from 30 to 60 feet wide for best production of lower vegetation.

Be sure to construct brushpiles from the cleared material. Pile the debris close to the clearing to provide easy access to the new low-growing vegetation. If possible, make the piles six feet high and 25 to 30 feet across so that a dog cannot crawl through or a person kick the structure over.

Criss-cross a few large logs or limbs for a foundation, or pile them over a stump or old tire to keep the cuttings from rotting down too quickly. Lay on slash

generously and put some heavy pieces over the top so that wind will not blow the brushpile apart. By the time such a pile rots, it will be replaced by a tangle of vines, shrubs and brambles--a "living brushpile."

In areas where woody vegetation is lacking, edge can be created by planting trees. The recommended planting season in Oklahoma is from December through March. Partial cover is as important in planting as it is with clearing techniques. Plant alternate groups of seedlings, being sure to leave occasional open spaces. Individual plants should be six to ten feet apart.

Mix evergreen plants with hardwoods for cover, just as nature would do it. Shrubs are excellent and provide fast growing overhead cover. An important concept to bear in mind is "the more varied the cover, the more wildlife it will support." Within three years these plantings should begin providing excellent cover.

After establishing or increasing edge by either clearing or planting, you may find it helpful in eastern areas of the state to till and plant a portion of the open area with *sereica lespediza*. The seed of this deep-rooted perennial legume may be purchased at most feed stores and should be planted in early spring. Thirty pounds of scarified seed per acre will provide quail with excellent nesting cover as well as some overhead protection.

One method of maintaining a variety of plant species is to periodically plow and cultivate open land in contour strips allowing nature to provide its own regrowth. This alternate plowing technique will save the second year grasses needed for nesting cover. If mowing is required, wait until August when most nesting is over.

By fencing off shelterbelts, ponds, ditches, woodlots or any other habitat area you will protect both food and cover against grazing. A program of rotation grazing of cattle can be instituted on such land with little or no harm to wildlife numbers. Allowed to be overgrazed the land provides little cover for wildlife. Ungrazed it may become too dense for movement of wildlife.

In the maintenance of your land for wildlife, avoid spring burning of fence rows, marshes, swales, woodlots and croplands. Fire destroys humus, wildlife food, cover, nests and the young of wild birds and animals.

Food

It takes a wide variety of food to meet all the different wildlife needs. From the feeding of young to individual taste preferences, the change in food types is constant and endless. This food must also be available year round in quantities abundant enough to support the demands of the existing population.

To supply any kind of wildlife, food must be located where the animals are protected while they are feeding. It differs with the species. For example, antelope, which depend on eyesight and speed to escape predation, need their food out in the open. Bobwhite quail, on the other hand, need overhead protection from winged enemies and surrounding cover to shield them from four-footed predators. Bobwhite food should be available in or very near good cover.

As much as possible, encourage the growth of natural foods. They require no help, since they reseed themselves once established. The following table lists the most popular native bobwhite quail food sources in Oklahoma:

Animal matter (insects)
Vegetation (stems and leaves)
Seeds
Ragweed (ambrosia)
Lespedeza)
Witch grass (panicum
Doveweed (croton)
Sunflower (helianthus)
Wild bean (strophostyles)
Partridge pea (cassa fasciculata)
Acorns (quercus)
Dallisgrass (paspalum)

In old fields and pastures where thick non-food-producing grasses tend to choke out desirable food plants, strip plowing along cover can again be employed for the growth of excellent native foods. By eliminating some portions of the dense tangle of old grasses, fresh seed becomes available to wildlife that otherwise would be unable to get at the hidden food.

Plowing should be done in January, February, or March, before either the growing or nesting season begins. Strips should be at least 15 feet wide and not less than 100 feet long, winding along next to the overhead cover. Care should also be taken to follow the contour of the land to prevent erosion.

When clearing sections of thick woody cover, be sure to leave as many nut trees as possible, even if they occur in the center of the new opening. Fruit trees are also extremely attractive to most birds and animal species. Preserve these valuable food trees when clearing, and whenever possible, include them in all plantings for wildlife. The following are recommended for Oklahoma's soils and climate:

- Autumn or Russian olive
- Wild black cherry
- Honeysuckle
- Redcedar
- Mulberry
- Red haw
- Wild crabapple
- Wild plum
- Sumac
- Black locust
- Mesquite
- Persimmon

If your land supports some domestic field crops, leave five to ten rows standing and unharvested along the outer border for wildlife. If not, you may want to try some strip plantings to provide extra food. These wildlife food patches are recommended for every 20 acres of land.

Each plot should be at least a quarter-acre in size and the planting should include a variety of seed to provide food during all seasons. Spring-planted foods important to quail and other seed-eaters include the sorghums and millets, plus Korean and bicolor lespedezas. Fall plantings of vetch, oats and wheat are helpful. For best results sorghums should be planted in rows. The others may be broadcast. On poor soil, fertilizer should be used.

Water

Water in some form is an essential part of all wildlife habitat. The kind and amount of water needed varies with the species. For fish it provides food, oxygen, cover and a transportation medium. Water supplies waterfowl with food as well as protection from enemies that cannot fly or swim. All wildlife species need water to survive. Most species drink it, but some satisfy their water needs by eating succulent vegetation or from dew.

Ponds or other wetlands are necessary for maintaining appreciable numbers of most kinds of wildlife. Even though many forms of wildlife in our area can obtain their required water from vegetation, a water source, such as a pool or stream, will support attractive lush vegetation.

In western Oklahoma, ponds and streams are somewhat less common than in the east. Where they exist they are often seasonal, with vastly fluctuating water levels.

Even so, much of the wildlife of the area will be found near their banks. Ponds can be constructed wherever water flows, even if the flow is very irregular.

For best results construct your pond so that it covers at least a 10 to 15-acre area. A water depth ranging from 18 to 24 inches at its minimum during periods of drought should be maintained.

For maximum growth of vegetation, ponds should have gently sloping shorelines, although for best fish production a rapid drop-off is more ideal. Another wetland habitat situation may be developed by establishing a nesting island or islands for use by waterfowl or shorebirds.

Aquatic vegetation will begin to appear naturally in and around the pond within two to three years following inundation, providing soil and water conditions are favorable for plant growth. To protect this plant life and still provide adequate watering facilities for livestock, fence off most of the pond, leaving a small access area for cattle.

The pond perimeter can also be enhanced to attract wildlife by planting food and shelter-producing trees and plants. Keep in mind the need for open space, grasslands and the importance of maintaining an "edge effect."

All in all, the well-balanced water area, with the vegetation that grows in or near it, produces and supports rich and varied wildlife populations. The extent

to which it can do this depends on two things: the fertility of the water itself, as determined by the watershed and the absence of pollution unfavorable to aquatic life.

Living Space

Most wildlife species have a limit as to how much crowding they can take. This is rarely achieved however, except in the case of predators. All birds and animals have minimum requirements for movement and for the amount of confinement they will tolerate. In other words, you can maintain quail on 40 acres but not antelope.

Many farmers, once proud of their clean fence rows and mowed landscape appearance of their land, are now realizing something is lacking in its natural beauty. From an economic standpoint, brushy fencerows, woodlots and creek banks are an asset in that they afford protection to livestock and stabilize the soil. Protected from clearing, burning, grazing and spraying, such natural habitat can double or triple the wildlife on many farms.

Cover, food, water and living space properly understood and managed on your land can produce a condition of habitat teeming with life. For additional information concerning planning habitat improvements or making wildlife plantings on your land, write to: Habitat Improvement, Oklahoma Department of Wildlife Conservation, 1801 N. Lincoln Blvd., Oklahoma City, OK 73105.

ACTIVITIES THAT
FEATURE
HABITAT OR WILDLIFE

How do ants find food? Can they discover a new route to it when the old route is closed? What do ants do when they meet? These are just a few of the questions you can find answers to by----

Building Your Own Ant Maze

With the directions on the facing page, and with help from an adult member of your family, you can build an excellent ant maze. This article tells you how to do it, how to collect some ants, and how to set up the maze.

By running your ants through the maze, you will discover many interesting things about them--their feeding habits, the way they meet each other, how they find their way about..

How to Collect Ants for Your Maze

When you collect your ants, take a spade, a large spoon, and the nest jar, using an extra lid without holes in it. Two kinds of ants that you can easily find for your maze are (1) the medium-sized black ants that nest in lawns, in gardens, and under rocks in fields, and (2) the gray field ants that often nest under stones.

When you find a nest, dig up the clump of earth containing the opening. Look for the ants' tunnel beneath it. Dig along the tunnel carefully, examining each spadeful for chambers of the nest. Scoop up the ants, their cocoons, and the pale, grub-like larvae, and drop them in your nest jar. If you dig far enough, you may

capture the queen. She will be considerably larger than the workers around her. Try to get the queen. Without her, your ants will die sooner than they would normally.

After you get your ants home, connect the nest jar with the maze, drop water in the moisture tube, and cover the jar. By keeping out the light you will encourage the ants to build tunnels next to the glass where you will be able to see them. Leave the ants alone for a day or so to get used to their surroundings. Then try some experiments.

How to Observe Your Ants

Put your ants on a regular feeding schedule. This is important. Mix a half teaspoonful of sugar in half a cup of water and store it in a clean bottle. Feed your ants at the same hour every day by using a clean medicine dropper and putting four or five drops of sugar water on a piece of cardboard. Place the piece of cardboard in the feeding chamber. (At this stage, both maze barriers should be left in the open position.) After a while the ants will find their way from the nest into the plastic tube, through the maze, and into the feeding chamber.

Starting half an hour before feeding time, keep a record of where the ants are moving. Every ten minutes during the half-hour, count the number of ants in the feeding chamber. If no ants are in it, enter 0 in your record. After the ants have learned to find their way into the feeding chamber, count the number of ants in

the chamber every 10 minutes after feeding time for half an hour, and keep a record of the totals.

Do this exactly the same way for several days. Use a piece of clean cardboard each time you feed them. Be sure the light always shines on the maze and feeding chamber from the same side.

Get a magnifying glass and watch the ants closely. What does an ant do when it finds food? What do the ants do when they meet each other? Do most of them follow one pathway through the maze? How long does it take most of the ants to learn when it is feeding time?

After the ants are used to the trip to the feeding chamber, make a dead end in the maze by sliding the maze barrier B_1 into the passageway to block it off. The barrier must fit snugly in its groove and against the center block (H) so the ants cannot get past. What do the ants do when they come to it? How soon do they find the other way through the maze? How long does it take before most of the ants have learned to bypass the dead end?

When the ants have learned to avoid the barrier, open it again and close barrier B_2 . How long does it take them to find the new pathway to the food?

Change the ants' food from time to time. Double the amount of sugar in the mixture. Cut it in half. Try different kinds of food. How do these changes affect the ants? Shift the light from one side of the maze to the other. Does this affect the ants? How?

Not all of these things are easy to do, and you may have to try more than once until you succeed. But you will find that the joy of running tests with your own ant colony is worth all the work.--Paul Showers

HOW TO BUILD IT

Cut the molding into strips 3 1/2 inches long. With it build two 3-inch fences near the ends of the board, overlapping the ends of the strips. Cement the molding in place. With a small saw cut gates in the fences at (E) and (F) just wide enough so that the ends of a glass tube fit into them snugly. Cut a gate at (G) just wide enough for the flexible tubing. Place the 2-inch-square wooden block (H) exactly in the center of the right-hand fence and cement it down. This fence now has a passageway all around the inside. It is the maze chamber.

To make the maze barriers, cut a slit the width of the saw blade at B_1 and another at B_2 . Now cut out two strips of cardboard in such a way that they slide snugly back and forth in slits B_1 and B_2 . The diagram shows the B_2 barrier in the closed position blocking off the passage; the B_1 barrier is shown open. The fence at the other end of the board is the feeding chamber.

Now connect gates (E) and (F) with a glass tube, fitting the ends into the openings. Fit one end of the flexible tubing in gate (G). For tight fits, you can

twist rubber bands around the ends of the tube and tubing, or fasten adhesive tape around the ends. Fasten both to the board with strips of tape (or use metal strips and screws as shown in the diagram). Cut some weather strip-
ping into pieces 3 1/2 inches long and with china cement fix them around the top of the maze and feeding chambers. Cover the gateways with the strips, allowing the cement to run down around the ends of the tubing to fill the chinks. Make sure the cement does not clog the tube openings. Cement a weather strip covering on the top of block (H). When the cement is dry, cover the maze and feeding chambers with squares of glass, holding them in place with strips of adhesive tape (or metal). Another way to hold down the glass tops is to stretch rubber bands between screwed hooks (see diagram).

Your ants will need a nest to live in. Fill about half of the large glass jar with earth. Make two holes in the lid. Push the flexible tube from the maze through one hole until part of it barely touches the earth. Push a glass tube through the other hole, forcing it well down into the earth. Ants must have moisture, but not too much. Drop water down the glass tube with a medicine dropper so that the earth around the base of the tube is kept damp. Keep the earth moist but not wet. For tight, ant proof connections, you can twist rubber bands around both tubes just above and below the lid.

Materials You Will Need

- 1 smooth board 6 inches wide, 2 feet long
- 3 feet of wooden molding 1/2 inch square
- 3 feet of felt weather stripping 1/2 inch wide
- 1 block of wood 2 inches square, 1/2 inch thick
- 2 glass tubes, each about a foot long
- 2 feet of flexible plastic tubing that you can see through. The glass and flexible tubing must have openings at least 1/4 of an inch across.
- 1 large wide-mouthed glass jar with a screw-on cover. A 2-quart mayonnaise jar will do.
- 2 pieces of window glass 4 inches square
- china cement
- a small saw
- a pair of sharp scissors
- adhesive tape

Apartment Living in the Forest

A forest is a community of living. There are similarities between a forest and an apartment house. Both have different floors. A large mature forest has many different layers formed by plants.

In the basement of the forest live such things as mites, millipedes, insect larvae, moles, shrews, centipedes, spiders, ground beetles as well as toads, lizards, snakes, skunks, woodchucks, and pocket gophers.

The lobby of the forest is the ground surface with its fallen leaves or needles as tree-to-tree carpeting. The deer, rabbits, chipmunks, fox, raccoons, and some birds make use of the lobby although some may visit other floors. Under the carpet of the lobby live slugs, snails, beetles, moles, crickets and many other animals. Some of these move into the basement but rarely are these seen unless one looks under the leaf litter which covers the ground.

Dwellers from the upper floor such as chickadees occasionally drop down for a tasty morsel of food. On the lobby floor, a convention of ants can be observed but their real business, the tending of eggs and larvae, goes on in the basement.

Above the lobby is the mezzanine. This usually is an incomplete floor and used only a part of the year for conventions and the like. The mezzanine floor is the herbaceous layer of the forest with grasses and flowering

herbs occurring in patches. During the winter this floor hardly exists but in the spring, jack-in-the-pulpit, lily-of-the-valley, trillium make an almost continuous layer. A few birds may nest on this floor while others eat the insects found here.

Above the mezzanine are the resident floors. The first floor is the layer formed by shrubs, from 4 - 8 feet high, such as mountain maple, thimble-berry, mountain mahogany, currant bushes, snowberry bush, saplings and vines. Here can be found tent caterpillars, aphids, tree hoppers, etc. as well as the nests of birds such as the towhee and warblers.

There are no elevators in the forest but the tree trunks serve as stairways with squirrels running up and down the trunks. Nuthatches, woodpeckers, and creepers are noticeable users of the forest stairs. The tree trunk forms a vertical layer with many inhabitants such as beetles, nesting birds such as woodpeckers, chickadees, flycatchers, owls, and tree swallows. The tree trunk also is an area where insects may winter as eggs, immature or adult forms, that provide food for nuthatches and woodpeckers.

The next floor would be the small tree layer. This floor is inhabited by birds of many species both for nesting and singing. It is here that hummingbird nests are found. The top floor or penthouse is the canopy of the forest made up of the highest trees. The number and

density of these trees regulate the temperature of all other floors and the amount of sunshine that reaches any given area. Typical inhabitants of the canopy are cicadas, hawks, owls, and warblers.

To think of the forest as a hotel or an apartment is a useful concept and serves to introduce the subject that botanists call stratification.

Regardless of what is known about those animals and birds which can be found on different floors, much more needs to be known.

LESSON PLAN OUTLINE FOR INVESTIGATING ENVIRONMENTAL HABITATS

Set the stage for this investigation by reviewing quickly what will take place in the allotted time. For example: In the next four hours we will investigate several environmental habitats; infer how animals fit into food chains and energy cycle, and how they are important to the environment; record changes in habitats and discuss what we can do as citizens to improve the biological interactions in our environment. (You might want to read the behavioral objectives at end of lesson and refer back to them as an evaluation of session.)

I. OBSERVING AND MEASURING ANIMAL SIGHTING AND EVIDENCES

Questions and Discussion (10 minutes)

1. What animals would we expect to find living in this area? (vertebrate, invertebrate)
2. What are the needs of these animals?
3. What are some names of the place where animals live?
4. Where would you look for animals around here?
5. Describe and pass out TASK A and B cards.

Task A (30 minutes) Work in small groups.

1. Explore as many places (environments or habitats) as you can from _____ to _____, and record animals that you see or any evidence of animals. As you inventory the animals or their evidences, figure out some way of recording amounts of evidences and animals seen.
2. Look for and list evidence (signs) of animals (partly consumed foods, excrement, homes, bird nests, feather, etc.).
3. Observe and list different habitats for wildlife in area. (Grass, cultivated field, hedges, swamp, etc.)
4. Observe and list animal foods in area.

HABITAT INVENTORY AND COMPARISON

Task B (30 minutes) Work in small groups.

Select three different habitats and compare the numbers of animal organisms and the characteristics in each.

Habitat I

Habitat II

Habitat III

Characteristics
of Habitat I

Characteristics
of Habitat II

Characteristics
of Habitat III

Questions and Discussion

1. What animals did you find in each habitat?
2. Which habitat had the most animals? Why?
3. What were the characteristics of each habitat?
4. What could account for the differences and similarities of the habitats?
5. What factors made one habitat more desirable than another?
6. Pass out Task C.

Task C (15 minutes)

Build a food pyramid showing the comparative amounts of animal and animal evidences seen.

Questions and Discussion (15 minutes)

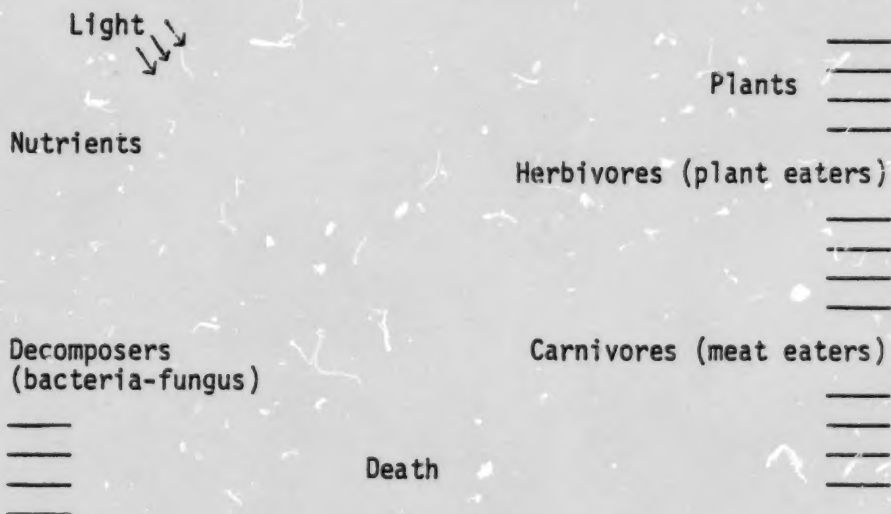
1. What did you find?
2. How many habitats did you investigate?
3. Which animals around here have the largest habitat, the smallest?
4. What was the largest group of animals found?
5. What do you think their main function in the environment might be?

Discuss terminology and definitions of herbivores, carnivores, omnivores, decomposers.

Pass out TASK D.

Task D (10 minutes)

List the animals you have seen or their evidences in the appropriate places in this diagram. Put in arrows. What other words and ways can you think of to illustrate a similar cycle?



What would happen if one group were eliminated?

If _____ group was eliminated, I think the following would happen:

Questions and Discussion (5 minutes)

1. What is the function of each part of the energy cycle?
2. What would happen if the decomposers were removed from this ecosystem?
3. How does the energy cycle relate to a food chain?
4. What is a food chain? (Who eats who?)

Pass out Task E.

Task E (10 minutes)

Construct a 5-stage food chain using specific animals seen so far.

II. OBSERVING AND RECORDING CHANGES IN ANIMAL HABITATS**Questions and Discussion (10 minutes)**

1. How did your food chain relate to the energy cycle in Task D?
2. What is the difference between food chain and food web?
3. Look at your food chain and see if you can construct a web out of it.
4. What evidences of influences can you name that have affected this environment?

Pass out Task F.

Task F (20 minutes)

Describe in writing, 3 influences that you observed that have changed the habitats in this area, and the cause and effect relationships that occurred.

Consider:

- a. Evidence of change, influence that made it.
- b. What area probably looked like before change occurred and animals that lived then.
- c. What area looks like now and animals that live here.
- d. How the change affected the habitat and animal species that did and do live there.

Questions and Discussion (10 minutes)

1. Have individuals read their descriptions, and compare different descriptions.
2. What evidences did you find that show man's influence in this area?

III. COMMUNICATING FEELINGS, AWARENESS, & VALUES ABOUT THE ENVIRONMENT

Task G (10 minutes)

Describe how you feel about man's effect on one animal habitat you observed.

Questions and Discussion

1. Discuss results of Task G with group.
2. What are some things that man has done to effect the efficiency of the energy cycle?

Task H (15 minutes)

Describe in writing 3 things you can do in your everyday life to make the energy cycle more efficient and cause the least amount of harm to the ecosystem.

Select the one you think would be your best contribution. Describe the benefits of this action--

- a. Where you live--
- b. In your consumer habits--

Discuss results of Task H.

Summary Questions

1. What did we find out about animals in our field study session today?
2. Why are animals important in the ecosystem?
3. How can we summarize our investigations today?
4. What processes and methods did we use to find these things out?
5. Which of the behavioral outcomes did we accomplish in this session? (Read and discuss.)

Task I

Describe in writing how you feel about our session today.

BEHAVIORAL OUTCOMES IN KNOWLEDGE

Identify and describe 6 different animal habitats.

Construct a diagram of an energy cycle, using the evidences and sightings of animal life observed at the site.

Describe at least 4 cause-and-effect relationships of the role of the decomposers in the energy cycle.

BEHAVIORAL OUTCOMES IN FEELINGS, AWARENESS, VALUES, AND ACTION

Describe how you feel about man's effect on one animal habitat observed at the site.

Describe 3 things you can do in your everyday life to make the energy cycle more efficient, and cause the least amount of harm to the ecosystem where you live and in your consumer habitats.

This lesson plan was developed for use in teacher workshops by:
 Pete Hinds, Milwaukie, Oregon
 Ernie McDonald, Portland, Oregon
 Russ Hupe, Olympia, Washington

The lesson plan was revised in November 1971. It is suggested by the writers that continuous revision take place by people who use the ideas.

A LESSON PLAN FOR INVESTIGATING A FOREST ENVIRONMENT

Set the stage for this investigation by reviewing quickly what will take place in the allotted time. For example: In the next four hours we are going to make some inferences of why we think some things are the way they are based on observations; test out those inferences by experimentation, collect and interpret past events in this experiment, and explore ways that we can improve the efficiency of energy cycles. (You might want to read the behavioral objectives at the end of the lesson and refer back to them as evaluation of the session.)

The following activities may help you look for observable changes, relationships, patterns and trends, in order to interpret past events, understand present relationships, and indicate future trends in the forest environment.

The processes used in this lesson plan can be replicated in any environment. Some of the activities used cannot. In environments other than a forest, you may have to develop activities appropriate to the area.

I. OBSERVING AND INFERRING WITH CROSS SECTIONS (as an example of using observable evidences to infer past events in a forest)

Distribute cross sections and task cards. Cross sections of trees can be 4-6" in diameter or larger, and should show a variety of growth patterns and influences (fire, insects, etc.).

TASK A (on cards; 5-10 minutes)

Work with 1 or 2 people. Write down some things you notice about the cross sections.

Questions and discussion:

1. What are some things you noticed about the cross sections?
(Accept all comments from group. List on board or chart.)
2. Focus on 2 or 3 items for discussion:
Why did you say...(your cross section had evidence of fire)? (examples)
What could account for...(the rings being irregular)?
What are some things that could account for...?

TASK B (on cards; 10 minutes)

Work with 1 or 2 other people. Select 3 observations about the cross sections from the group list. List possible reasons for these observations. List ways you could set up an investigation to find out more about your observations and inferences.

<u>Observation</u> (What you noticed)	<u>Inferences</u> (Possible reasons for this)	<u>Investigations</u> (How we could find out)
1.		
2.		
3.		

Questions and discussion:

1. Ask for reports on the above chart from several groups.
(as time allows)
2. Which of these investigations could be carried out in this environment?
3. Keep your lists of observations and inferences for reference at the end of this session.
4. What could tree rings from this forest tell us about past and present events in this environment?

II. COLLECTING AND INTERPRETING DATA ABOUT TREE GROWTH RATE AND COMPETITION

Task C (with tree cores) requires preparation by the instructor before the session.

A tree stand should be selected for study, 4-5 trees tagged (trees should be selected that show effects of environmental conditions--injury, overcrowding, lack of sunlight, etc...). The tagged trees should be bored with an increment borer, by the instructor ahead of time. (Cores should be numbered

corresponding to numbers on the tree.) Putting tree cores in see-through plastic straws and then taping to a cardboard will help keep them longer if liquid resin is not available. In any event, keep the cores and labeled trees to use again. This eliminates the necessity of reboring the trees.

NOTE: Maybe you can find and use stumps of trees that grow under a variety of competition influences instead of tree cores.

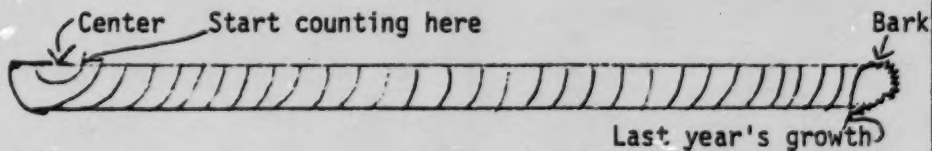
TASK C (Part 1; 15-20 minutes) Work in groups of 4-5 people.

1. Observe the tree core your group has been given and record the following information: (See drawing of tree core to help interpret the tree core you have been given.)

Tree #	# Dark rings from center to bark (approx. age)	# Dark rings in last inch	Remarks about the pattern of the rings

2. When your group has the above information, one person from the group should record this information on the blackboard or easel board. Chart to be like TASK C, part 2.

DRAWING OF TYPICAL TREE CORE



(Part 2; 10-15 minutes) Work in small groups.

Record the following information about tree cores from the master chart. (Instructor will provide the diameter information.)

Task C, continued:

Tree #	# Dark rings from center to bark (Approx, age)	Diameter of tree trunk (Cir. +3)	# Dark rings in Last inch	Remarks about the ring pattern
1.				
2.				
3.				
4.				
5.				
6.				
7.				

Questions and discussion:

1. What similarities do you notice in the data about the trees?
2. What differences do you notice in the data about the trees?

TASK C: (Part 3) (20 minutes) Work in small groups.

Set up an investigation to find out reasons for some of the differences in the data.

1. Select 2-3 trees from the list that show differences in the data.
2. Which trees did you select? (Indicate by number)

3. Why did you select these trees? _____

Go with your group to the site of the trees you selected for investigation and do (Part 4).

(Part 4; 30-40 minutes) Work in small groups.

Collecting and Recording Data

Record your observations:

Interpreting Data

Record possible interpretations of the above data:

Summarizing your Investigation

Write your group's summary below, including:

- what you were trying to find out
- what data you collected about it
- what interpretations you made
- what other data would you collect about your investigation?

Questions and discussion:

1. Ask for 2-3 minute summaries from several groups. (as time allows)
2. What problems did you encounter in this task?
3. What other data could you collect about your investigation?
4. What does the information tell us about the past events of this environment?
5. How would you summarize the major factors affecting the growth of this forest?

III. INTERPRETING PAST EVENTS

TASK D: (30-40 minutes)

Look for evidence of change (natural and man-made) in the environment. Record and fill out other columns.

Evidence of Changes in the Environment	What Might Have Caused Them?	Effect on the Environment

Describe the way the area around you looked:

25 years ago

Describe how you think the area around you might look:

25 years from now

Questions and discussion:

1. What evidence of change did you find?
2. What might have caused this?
3. What was the effect of _____ (this change) on the environment? Allow time for interchange of ideas between group members. The same changes may have been noticed, and there may be many interpretations of their causes and their effects.
4. What do you think this area looked like 25 years ago?
5. How do you think this area will look 25 years from now?

TASK E: (10 minutes)

Describe in writing how you feel about the changes in this environment.

IV. INFERRING CHANGES IN A ROTTEN LOG OR STUMP

Find a rotten stump of log.

Questions and discussion:

1. What things about this stump give us clues about the past events that have taken place?
2. What factors caused these things to happen?

TASK F: (15-20 minutes) Work in groups or by yourself.

NOTE: DO NOT TEAR THE STUMP APART! Discuss why.

What things are changing the rotten stump now? Record below:

*Living things	Effect on Stump
*Non-Living things	Effect on Stump

Questions and Discussion:

1. What cycles are taking place in the rotten log or stump?
2. In the space below, construct a diagram of one of the cycles taking place in the rotten log or stump.

TASK G: (15 minutes) Work in groups.

Construct a diagram of one of the cycles taking place in the rotten log or stump.

V. TRANSFERRING THE PROCESS TO OTHER ENVIRONMENTS

Questions and Discussion:

1. What are some other things in this environment that could help us further interpret the landscape and what it can tell us about the landscape. List on board.
2. Using one of the items listed in question 1 or another you can think of, do TASK H.

TASK H: (30 minutes)

Describe in writing an alternative activity you could have done to establish a time sequence for the past events in this environment.

Describe in writing an activity you could do in a city environment to establish a time sequence for the past events in the environment.

Activity

What it would tell you about the past events in the area

Describe an activity you could do in the area around your school to establish a time sequence for the past events in the area.

Activity

What it would tell you about the past events in the area

VI. COMMUNICATING FEELINGS OF AWARENESS THROUGH SKETCHING

Distribute sketching paper, and pieces of charcoal from a campfire or fireplace.

TASK I: (give these directions verbally)

(Use sketching paper)

Construct a sketch using charcoal from a campfire or fireplace.

Other sketching materials will be given to you as you work.

NOTE: Subject of sketch depends on the environment.
It can be anything that is significant about the area...
rotten log, stump, or snag
an old homestead, fence, or barn
a city building, transmission tower, or freeway

While people are sketching, go around and give them:
rotten wood - brown; dandelion leaves - green; dandelion
flowers - yellow; other goodies, in season
If you're not in the woods, IMPROVISE!

VII. COMMUNICATING FEELINGS OF AWARENESS AND VALUES THROUGH WRITING

Note: Begin this part when about half the people finish their sketch.

TASK J: (give these directions verbally)

Using your pencil or pen, find a place on your sketch (across the bottom, or down the side) to write some things.

Write 2 descriptive words about the stump. (words that tell what it looks like)

Write 3 actions words about the stump. (words that describe processes or changes taking place, or things happening to it)

Write a short phrase (4-5 words) that tells how the stump affects the rest of the environment. (a phrase to describe its value or usefulness or one describing any thought you have about the stump)

Write 1 word that sums up everything about the stump. (a word that suggests a comparison, an analogy, or synonym)

Optional:

Now, if you wish, go back and give a title to what you have written.

Congratulations. You have just written a poem about the stump or whatever you wrote about.

Note: Pace the above directions to the needs of the group. People shouldn't feel pressure while writing this -- be casual. (It's good to mention that they may not wish to write something for every directions that is given.) Review the directions now and then for people still thinking.

Have people read their writings if they wish.

Questions to think about:

In what ways does this description show your feelings and awareness of the environment?

SUMMARY QUESTIONS

1. What did we find out about the environment in our session today? (list on chart, if time)
2. Why are these things important to the way we manage the environment?
3. How can we summarize our discussion? (or investigation) (What are some big ideas that would sum up what we've just said?)
4. What methods and processes did we use in our investigations?

TASK K

5. Describe in writing how you feel about our session today.

BEHAVIORAL OUTCOMES IN KNOWLEDGE

As a result of these activities, you should be able to:

List at least 3 observations about the cross sections provided, and infer possible reasons for each observation.

Describe ways to set up an investigation to find out more about the above observations and inferences.

Set up an investigation (collect and record data) to find out reasons for growth rate differences in a given stand of trees.

Describe activities appropriate to other environments for interpreting the landscape.

Identify and list at least 3 evidences of change in the environment, and infer the cause-and-effect relationships of those changes.

Construct a diagram of a cycle in a rotten stump.

BEHAVIORAL OUTCOMES IN FEELINGS, AWARENESS, VALUES, AND ACTION

As a result of these activities, you should be able to:

Describe how you feel about one change in this environment.

Communicate feelings of awareness by constructing a sketch of a given object in the environment, using natural materials.

Communicate feelings, awareness, and values by describing in writing the effect of a given object on the environment.

EQUIPMENT NEEDED

- 30 cross sections of trees
- 6 increment cores (preferably in plastic) from numbered trees
- 30 hand lenses (optional)
- 30 pieces sketching paper
- lab sheets
- task cards
- natural materials for sketching

This lesson plan was developed for use in teacher workshops by:
 Martha Neyland, Stevenson, Washington
 Jeannie Williams, Salem, Oregon
 Charline McDonald, Portland, Oregon

The lesson plan was revised in November 1971. It is suggested by the writers that continuous revision take place by people who use the ideas.

SOME "AROUND THE SCHOOL YARD" ACTIVITIES

USING THE SENSESEquipment Needed:

1 sheet of drawing paper (8½ X 11") (manila) per child
 Each child brings one dark crayon (green, black, brown, etc.).
 Each adult leader should have a clip-board and paper and pencil.
 List as many of the children's comments as possible for each activity.

Tell the children you are writing down their descriptions.

At intervals throughout the activity, read back their comments to them.

At the end of each activity, read what was said as a summary.

Group leaders should give the comments and descriptions to the teachers at the end of the field trip for use back at school to make experience charts and story-writing.

"Sound" Hike - (10-15 minutes)

Group leader takes kids for walk.

Stop at intervals along the way. Have kids close eyes and listen for 30 seconds. At end of 30 seconds, kids describe a sound they hears.

(Group leader should write down the way each kid described his sound.)

Try to stop in different places so there will be a variety of sounds to be heard.

See how many different sounds your group can discover.

Ask: Which sound did you like best?

Why?

Does it remind you of something else?

Which sound is the loudest? The quietest? The highest? The lowest?

Mini-Forest - (Approximately 15 minutes)
(Investigating an Arm-Circle of Grass)

1. Lie on the ground, face down.
2. Make a circle by stretching your arms out in front of you on the ground.
3. Find at least five different plants inside that circle made with your arms.

4. See if you can find any tiny animals crawling through the grass.
5. What else do you see? (Any dead leaves or twigs?)
6. Spread the grass apart and describe what you see.

Big Idea - Many plants and animals live together in a community.

Sketching - (15-20 minutes)

Find 2 trees with different shapes. Observe and sketch one tree at a time.

1. Look at the tree from a distance.
2. With your finger, "trace" (in the air) the shape of the tree. (Do this from the ground up to top and from top down to ground.)
3. Describe the shape of the tree.
4. Make a "telescope" with your hands. Look through this "telescope" at your tree from a distance.
5. Describe how the branches go out from the trunk. (up? Out? Down?)
6. Hold out your arms to show how the branches grow out from the tree trunk.
7. Go closer to the tree. What else do you notice about it?
8. Get close to the trunk of the tree. Look up into the tree. What do you see?
9. Go to a comfortable place where you can see your tree. Sketch it with the crayon you brought.
10. Repeat procedure for second tree.

Add some of nature's color to your sketch.

Pick some grass. Use it as a crayon. Rub it around on the paper to show where the green is on your tree.

Pick a yellow dandelion blossom. Use it as a crayon somewhere on your sketch.

"Touch and Feel" Hike - (Approximately 10-15 minutes)

Group leader takes kids for a walk. Gives following directions at intervals along the walk. (Add others when appropriate.)

1. Find the hairiest leaf around. Bring back a tiny bit of it. Compare with your other group members.
2. Find the softest leaf.
3. Find the smoothest rock.
4. Find the roughest twig.
5. Find something cool.
6. Find something warm.
7. Find something bumpy.
8. Find something dry.

"Color" Hike

1. Look for things that are different colors of green. Bring back 3 or 4 green things.

Arrange them in your hand according to lightest green to darkest green.

2. Find and describe things that are:

yellow-pink-brown-grey:

MATH MEASUREMENT

Determine length of step. Use this unit of measurement for:

Calculate perimeters and areas of schoolyard activity spaces (playfield, ball diamonds, open fields, etc.). Convert measurements to meters.

Construct a conversion scale for metric measurements using the length of your step.

Find out how many times you need to run around the playfield to run a mile.

Find out how many acres are on your playfield.

Construct a map of the schoolyard using the plane table method.
Map to scale.

(Use Boy Scout Merit Badge Series on Surveying as a reference.)

Determine heights of trees, utility poles on or adjacent to schoolyards, using triangulation and a stick at least as long as your arm.

Compute cubic volume of trees and utility poles using above method.

Determine percentages of slope of land using a yardstick, another stick, a baby food jar half filled with water.

Construct a topographic model of your schoolyard using layers of cardboard.

Learn to use compass and determine cardinal directions on schoolyard. Orient map and compass to actual landscape from schoolyard.

Observe and sketch geometric shapes seen on schoolyard or adjacent areas. (Find triangles, circles, rectangles, squares, lines, etc.)

THINGS TO DO WITH TREES

Observe and compare the shapes of trees.

How many shapes can you find?

Discuss the shapes. Is it triangular? Like a column? Evenly tapered? Low and spreading? Regular? Irregular?

Find two trees with distinctly different shapes and sketch them.

Look for different shapes of trees on the horizon.

Observe and compare the branching of trees.

How many different directions do trees branch?

How do the branches grow out from the tree? Straight out?

Out and then down? Out and then up at the ends?

Find two trees whose branches grow differently and sketch just the way the branches grow.

Write a comparison about the differences in branching of these trees.

Observe and compare the foliage of trees.

How many different textures of foliage do you observe?

Do the leaves grow up from the branches? Or do they grow down?

Do the leaves grow all along the branch, or only at the ends?

Do the leaves hide part of the branch?

Find two trees with different textures and sketch your impression of the textures.

Observe and compare the colors in trees.

How many different colors can you find in the trees?

Observe one tree at various times of a sunny day and compare the light patterns.

Observe, sketch, or photograph the designs and patterns made by the shadows of trees.

Observe and compare the bark of trees.

How many different textures can you find?

Make bark rubbings with newsprint and crayon.

How do trees enhance the environment of your schoolyard?

WEED PATCHES

1. Look for the different colors of the plants. Arrange the colors in a list--lightest to darkest:

2. Count and record the different kinds of plants that are below your knees:

- a. How many plants have few leaves? _____
- b. How many plants have many leaves? _____
- c. How many kinds of plants are sticky? _____
- d. Do any of the plants have flowers? _____
- List the colors of the flowers:

- e. Do any of the plants have seed pods? _____
- Describe the different pods: _____

3. Now record the same data for the plants that are above your knees:

- a. Number of different kinds: _____
- b. Plants with many leaves? _____
- c. Plants with few leaves? _____
- d. Plants that are sticky? _____
- e. Do any of these plants have flowers? _____
- List the colors of the flowers:

- f. Do any of these plants have seed pods? _____
- Describe the seed pods: _____

4. Are there any plants higher than your head? _____
- Are there many, or just a few? _____
- Describe these plants: _____

5. On a separate piece of paper, choose one of the following to do:
 - a. Choose one weed and write a riddle about it, using four of the five senses to describe it.
Which of our five senses would you not use? _____
 - b. Write a poem describing the weed, or a poem telling about the color "green".
 - c. Write an imaginary story explaining how the tallest weed became so tall.

INTERPRETING CULTURAL HISTORY AROUND SCHOOL

Inventory building structures within a given distance from your school.

Develop a classification system for types of buildings. (Shape, roof shape, and type, materials in construction, etc.)

Develop a means of classification for age of buildings.

Map the vacant buildings within a given distance of your school.

Determine how long buildings have been vacant. (Observe deterioration, interview local residents, consult written records, etc.)

What function did the building perform when it was in use?

What factors caused the building to become vacant?

Who owns the building now? Is there another possible use for the building?

Make an inventory of fences within a given distance of your school.

What different types did you find?

What different materials have been used in the fences?

Develop a classification system for the fences you observed.

Develop a chart showing the type of fences and their most common uses.

If possible, find pieces of discarded fences and construct a board of these, listing uses for each.

Use aerial photo to locate section corners in your area. If possible, go to that location and look for a witness tree. See if scribing is identifiable.

Locate the watershed in which your school is located. What land uses are in that watershed?

Locate the source of your community's water supply. What changes have occurred in the water supply situation in your community?

Char McDonald and Zee Butler 5/70

TURTLE TRACKER

Purpose: To trace the movements of turtles.

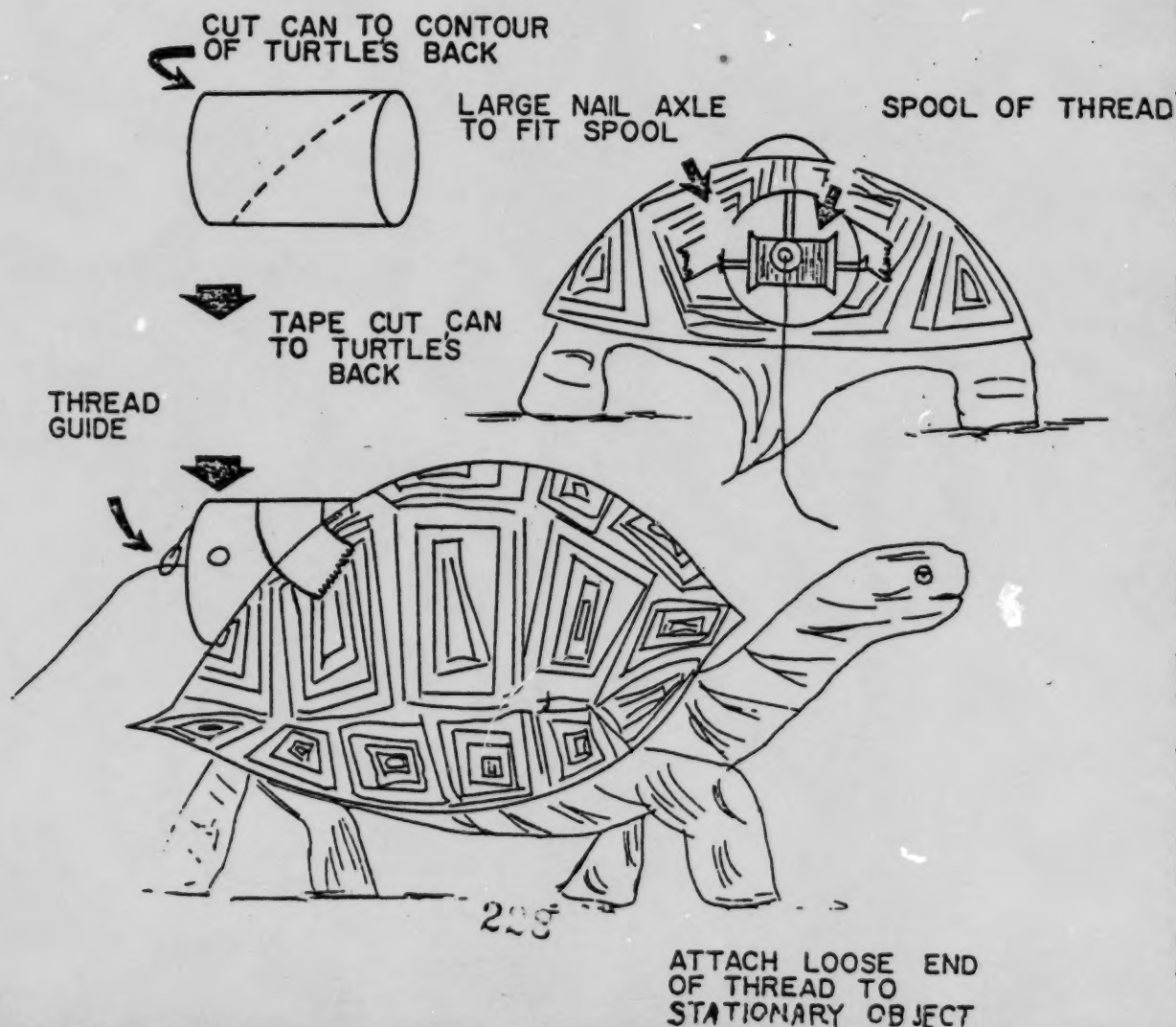
Materials: small can, spool of heavy thread, large nail, heavy tape, metal tab from a soft drink container for thread guide, plastic straw.

Procedure:

1. Cut a small can with a tin shears to conform to turtle's shell as shown in illustration.
2. Drive a nail through can near the end to act as an axle.
3. Cut two small sections of plastic straw to act as spacers between each side of the spool and the can.
4. Thread a spacer, spool, and another spacer onto nail. Bend part of nail exposed after being placed through can.
5. Attach the metal tab for a thread guide by taping or soldering it to the can.
6. Run thread through small hole punched in center of end of can and through tab. To eliminate sharp edges, sand smooth.
7. Tape can securely to turtle's back and attach end of thread to a stationary object.

Questions:

1. Is there a certain direction the turtle seems to be headed?
2. Does the turtle follow a pattern in its travels?
3. Are some turtles more active than others?



CASTING ANIMAL TRACKS

Much can be learned about animal habits by carefully examining the various tracks. To the experienced woodsman and naturalist, tracks and other signs left by animals are like an open storybook which tells what has been happening in the lives of these wild creatures. Plaster of paris can be carried to the area where the tracks have been discovered and castings made. If tracks cannot be found readily, the camp has animal tracks that can be imprinted into soft ground and then left to be discovered by the youngsters.

To identify an animal from its tracks and signs, there are certain clues to look for: (1) What is the general shape and size of the animal footprint? (2) Are there any tail tracks? (3) How do the positions of the tracks relate to each other? (4) Are there any claw marks? (5) Are there any other signs?

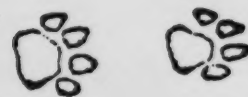
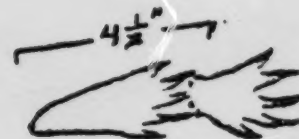
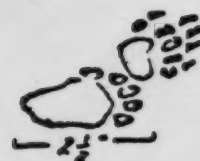
Generally, there are four categories of animal tracks. The track is a clue to the animal's body design:

1. Short legged types: These tracks are made by the long, slender bodied mammals, such as the mink and the weasel. Since they tend to move by bounding, the tracks of the hind feet are made behind the tracks of the front feet. When these animals are running, one may find that the tracks of the hind feet may fall into the tracks of the front feet or ahead of them.

2. The fat animals: These tracks are formed in two lines with the imprints close together. Animals that make these tracks have heavy-set thick bodies with short legs, and they tend to waddle. Examples of such animals are the bear, raccoon, porcupine, and beaver.

3. The varied leg length types: These animals generally have very short front legs with long hind legs, so that they tend to move ahead in hops or jumps. Their tracks are usually made with the paired tracks of the hind feet in front of the paired tracks of the front feet. The animals that make this kind of track are rabbits, hares, some mice, and squirrels.

4. Long legged types: These tracks are quite far apart and the tracks of the hind feet will often fall in the tracks of the front feet. The members of the bobcat, fox, dog, and deer families generally make this type of track.

BearMountain LionCoyoteMinkDeerRaccoonDogStriped Skunk

DIRECTIONS FOR CASTING AN ANIMAL TRACK

1. Clean track of loose particles of soil, twigs, leaves, or other litter.
2. Form two-inch wide strip of cardboard or tin into a ring surrounding the track. Press firmly into ground to give support, but allow at least one inch to form edge of mold for plaster.
3. Mix about two cups of plaster of paris in a tin can or plastic bowl, adding water slowly until it is about as thick as heavy cream. Pour carefully into mold until plaster is about to top. Allow plaster to harden at least fifteen minutes before lifting out of track. If soil is damp, hardening may take longer.
4. When cast is hardened, lift cast out, remove ring, and clean the cast by scraping with a knife blade and washing.
5. Apply thin coating of vaseline to track and surface of cast. Place on flat surface and surrounding casting with a two-inch strip of cardboard or tin as before.
6. Mix plaster of paris and pour into mold, making certain that top surface of casting is smooth and level with the mold.
7. Carefully remove mold when plaster is dry. Separate the two layers and wipe excess vaseline from face of cast and track. Scrape any rough places with knife blade, or use fine sandpaper to smooth. Wash in running water.
8. When cast is thoroughly dry, paint inside of track with India ink or black poster paint. Label with name of track. A coat of clear shellac or clear plastic may be applied to protect and preserve the casting.



1. Clean track



2. Encircle track with band of cardboard pressed into soil.



3. Pour plaster of Paris mixture over track.



4. Lift cast when hard. Clean carefully and coat with vaseline.



5. Surround casting with wide strip and pour plaster level with mold.



6. Separate the two layers of casting. Clean vaseline from track and smooth with knife blade.



7. When cast is dry paint inside of track with black India ink.

PUT ART TO WORK

By Iowa Hall

The use of ideas and concepts learned in a given study, such as conservation, environment, etc., for the purpose of relaying a message, crystallizing an idea, etc., is an art in itself. You as a teacher or the students you direct are limited only by personal imagination. Here is an opportunity unlimited!

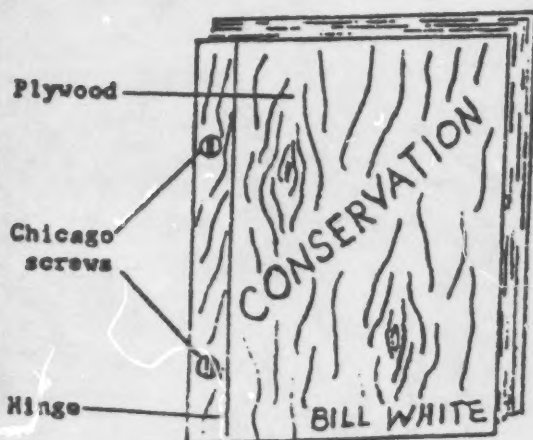
Following are a few suggestions which may give you some ideas to work with:



BOOKLETS



POSTERS

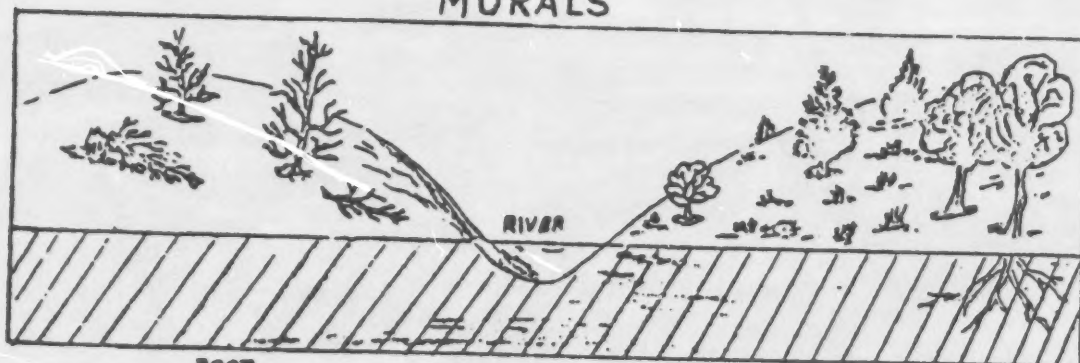


JOURNALS



SILHOUETTES

MURALS



ROOF

Extreme run-off. Muddy water and soil entering clear river water. Water table very low.

RESERVOIR

Water stored up in the ground and ground cover. Water table is high.

PUTTING ART TO WORK

BY IOWA HALL

BALANCE IN NATURE



HUMANITY SOMETIMES UPSETS THE BALANCE

OLD SAYING

"TO DESTROY THE MOUNTAIN IS TO RUIN THE VALLEY"

HELP!

PREVENT FOREST FIRES!

THERE'S NO ONE THAT CAN MATCH YOUR OWN EFFORTS

OLD SAYING

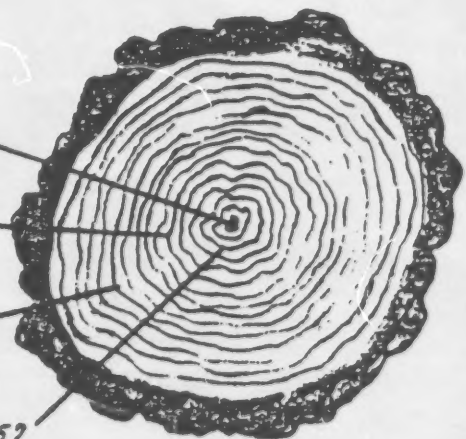
"TO RULE THE MOUNTAIN IS TO RULE THE RIVER"

TREE BORN ON APRIL 10, 1954

I WAS BORN ON MAY 5, 1959

I STARTED SCHOOL SEPTEMBER, 1965

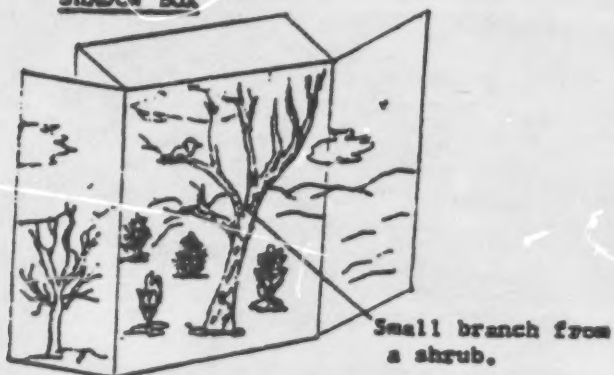
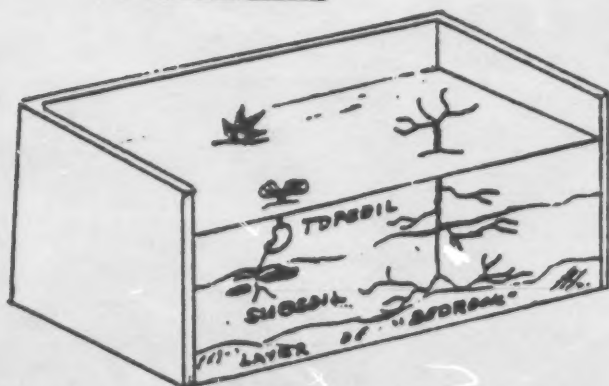
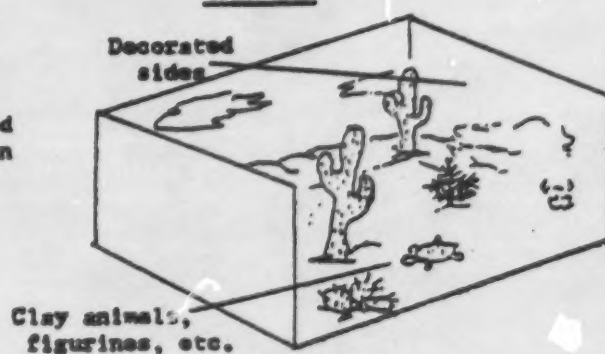
DAD MARRIED MOTHER JUNE 1, 1957



DIORAMA BOXES

By Iowa Hall

This is an excellent means of making a field trip or a unit of study "come to life." Pictorial, three-dimensional displays of animals, scenery, event, library books, etc., provide a good communication device. They are unbeatable for encouraging originality and maintaining interest.

COVERED BOXSHADOW BOXGLASS FRONT BOXOPEN BOXCOVERED FRONT BOXHELPFUL HINTS

Put birds, pond life, deer, coveats, etc. in their natural habitat.

Use clay, plastic, or stuffed animals, artificial birds, butterflies, flowers, etc.

Cover floor with various materials for textures to match scene.

DON'T MAKE BOXES TOO COMPLEX

THINGS TO DO:

Enroll yourself or your class in the "Acres for Wildlife" program. For more information write or call: "Acres for Wildlife", Oklahoma Department of Wildlife Conservation, 1801 N. Lincoln, Oklahoma City, Oklahoma 73105; 405/521-3855.

Plant tree seedlings on your "Acres for Wildlife" plot. "Wildlife Bundles", packages of 250 seedlings that produce wildlife food or cover, are available for only \$10.00. Contact the Forestry Division, Oklahoma Department of Agriculture, State Capitol, Oklahoma City, Oklahoma 73105; 405/521-3866.

By yourself or with your class, investigate several natural areas close to your home. Are the three basic needs of wildlife there? In what ways are these needs met, and what kinds of animals would you expect to find there? Make a list of these animals, and compare it to the animals you actually see.

Revisit one of these areas during a different season. What changes can you find in the type of cover available? Look for things wildlife could eat. Is the type and amount of food the same as your last visit?

HABITAT IMPROVEMENT QUIZ

1. Who is responsible for establishing rules and regulations (not laws) pertaining to fish and wildlife in Oklahoma? (a) Department of Tourism and Recreation, (b) U.S. Fish and Wildlife Service, (c) Department of Wildlife Conservation, (d) Oklahoma legislature.
2. Who enforces the fish and wildlife laws in Oklahoma? (a) local police officer, (b) Highway Patrol officer, (c) Game Ranger, (d) all of the above.
3. The best way to manage wildlife is by: (a) eliminating all wildlife predators, (b) creating good wildlife habitat, (c) releasing pen-raised birds and animals into the wild, (d) shortening hunting seasons.
4. Wildlife in Oklahoma is owned by or belongs to: (a) landowner, (b) state government, (c) federal government, (d) the public.
5. Hollow or den trees are valuable because they provide wildlife with: (a) food, (b) homes, (c) shade, (d) resting places.
6. One of the most popular den trees for wildlife is: (a) blackjack oak, (b) hickory, (c) sycamore, (d) hackberry.
7. Which of the following use den trees in raising their young? (a) squirrel and crow, (b) squirrel and wood duck, (c) raccoon and muskrat, (d) all of the above.
8. Mature oaks and hickories provide wildlife with this valuable fall and winter food. (a) nuts, (b) leaves, (c) berries, (d) all of the above.
9. Most wildlife populations are at their highest level during: (a) winter, (b) fall, (c) spring, (d) summer.
10. An example of good winter cover for quail is: (a) clump of cedar trees, (b) maize field, (c) Bermudagrass pasture, (d) mature woods.
11. The best nesting cover for quail should be found in a: (a) clump of cedar trees, (b) maize field, (c) field of native grass, (d) mature woods.

12. What is a good example of escape cover for rabbits?
(a) clump of cedar trees, (b) patch of briars or berry bushes, (c) bushy fence row, (d) all of the above.
13. An example of a wildlife travel lane between woodland and cropland might be a: (a) gravel road, (b) blacktop road, (c) field of Bermudagrass, (d) brushy fence row.
14. Brushy thickets and native grass would most likely attract which types of small game? (a) rabbits and squirrels, (b) rabbits and quail, (c) deer and squirrels, (d) quail and turkeys.
15. Which is not considered to be a woodland game species? (a) deer, (b) wild turkey, (c) pheasant, (d) squirrel.
16. Which of the following game species are migratory? (a) mallard duck, (b) bobwhite quail, (c) ring-necked pheasant, (d) all of the above.
17. What is responsible for more permanent loss of wildlife than anything else? (a) predators, (b) destruction of wildlife habitat, (c) hunting, (d) disease.
18. That part of the woods supplying the most food and cover for wildlife is the: (a) interior, (b) edge, (c) canopy, (d) none of the above.
19. Good habitat should have: (a) food, (b) water, (c) escape cover near a food source, (d) all of the above.
20. The species of squirrel most abundant in Oklahoma is a (a) fox squirrel (b) flying squirrel (c) gray squirrel (d) none of the above.

ANSWERS: 1-c; 2-d; 3-b; 4-d; 5-b; 6-a; 7-b; 8-a; 9-d;
10-a; 11-c; 12-d; 13-d; 14-b; 15-c; 16-a; 17-b; 18-b;
19-d; 20-a.

BIBLIOGRAPHY

Brown, Mickey, "Acres For Wildlife - Revisited", Outdoor Oklahoma, July-August, 1974.

"Building Your Own Ant Maze", Nature and Science, April 17, 1964.

Cook, Dick, "Shelterbelt - Guardian of the Plains", Outdoor Oklahoma, January, 1974.

Habitat Improvement, Department of Wildlife Conservation, 1801 N. Lincoln, Oklahoma City, OK 73105.

Hall, Iowa, Simple Projects For Outdoor Education, Utah State Board of Education, Salt Lake City, Utah.

Herd, John, "How Food Plots Help", Outdoor Oklahoma, February, 1973.

Kaupanger, Olin L., A Primer on Conservation, Colwell Press, Inc., Minneapolis, MN, 1962.

Kraznovich, Ron, "Wildlife Management Quiz", Outdoor Oklahoma, April, 1973.

Mr. Peanuts Guide to Ecology, Standard Brands Educational Service, Box 2695, Grand Central Station, New York, NY 10017.

Wille, Chris, "The High Cost of Beef", Outdoor Oklahoma, October, 1975.

-----, "A Home on the Range For Wildlife", Outdoor Oklahoma, February, 1976.

Williamson, Dick, "Where Have All the Critters Gone?", Outdoor Oklahoma, April, 1973.

B I B L I O G R A P H Y
O F
Conservation References

- Allen, Durward L., OUR WILDLIFE LEGACY. New York:
Funk and Wagnalls, 1962, 422 pp.
- American Association of School Administrators, CONSERVA-
TION--IN THE PEOPLE'S HANDS. Washington, D.C.,
1964.
- Ashbaugh, Byron L., TRAIL PLANNING AND LAYOUT, New York:
National Audubon Society, 1130 Fifth Avenue,
1965.
- Ashbaugh, Byron L., and Muriel Beuschlein, THINGS TO DO
IN SCIENCE AND CONSERVATION. Danville, Illinois:
Interstate Printers and Publishers, Inc., 1960,
163 pp.
- Bale, Robert O., CONSERVATION FOR CAMP AND CLASSROOM.
Minneapolis, Minnesota: Burgess Publishing
Company, 1962, 145 pp.
- Bathurst, Effie G. and Wilhelmina Hill, CONSERVATION
EXPERIENCES FOR CHILDREN. U.S. Department of
Health, Education, and Welfare, Washington,
D.C., 1957, 192 pp.
- Beard, Ward P., TEACHING CONSERVATION. The American
Forestry Association, Washington, D.C., 1948.
- Brehm, Shirley A., STUDY OUTSIDE THE CLASSROOM. Columbus,
Ohio: Charles E. Merrill Publishing Company,
1969.
- Brown, Robert E. and G.W. Mouser, TECHNIQUES FOR TEACHING
CONSERVATION EDUCATION. Minneapolis, Minnesota:
Burgess Publishing Company, 1966.
- Craighead, Frank and John, HAWKS, OWLS, AND WILDLIFE.
Harrisburg, Pennsylvania: The Stackpole Com-
pany, 1956, 443 pp.
- Crosby, Phoebe, JUNIOR SCIENCE BOOK OF ROCK COLLECTING.
Champaign, Illinois: Garrard Publishing Com-
pany, 1962.
- Dansmann, Raymond F., ENVIRONMENTAL CONSERVATION. New
York: John Wiley and Sons, Inc., 1959.
- Hamm, Russell L. and Larry Nason, AN ECOLOGICAL APPROACH
TO CONSERVATION. Minneapolis, Minnesota:
Burgess Publishing Company, 1964.

- Hammerman and Hammerman, TEACHING IN THE OUTDOOR.
Minneapolis, Minnesota: Burgess Publishing
Company, 1964.
- Highsmith, Richard M., Jensen, J. Granville, and Robert
D. Rudd, CONSERVATION IN THE UNITED STATES.
Chicago: Rank McNally and Company, 1962,
332 pp.
- Hillcourt, William, FIELD BOOK OF NATURE ACTIVITIES AND
CONSERVATION. New York: G. P. Putnam's Sons,
1961, 320 pp.
- Hitch, Allen S. and Marian Sorenson, CONSERVATION AND
YOU. New Jersey: D. Van Nostrand Company,
Inc., 1964.
- Huberty, Martin R. and others, NATURAL RESOURCES. Ed.
Martin R. Huberty. Natural Resources. McGraw-
Hill Book Company, Inc., 1964.
- Hug, John W. and Phyllis J. Wilson, CURRICULUM ENRICHMENT
OUTDOORS. New York: Harper & Row, 1965.
- Jaeger, Ellsworth, NATURE CRAFTS. Sixth Edition. New
York: The Macmillan Company, 1966.
- Marquis, Ralph W. (ed.). ENVIRONMENTAL IMPROVEMENT.
The Graduate School, U.S. Department of Agri-
culture, October 1966.
- Mash, Norman F., OUTDOOR EDUCATION ON YOUR SCHOOL
GROUNDS, Published by the State of California,
Office of Conservation Education, Sacramento,
California, May 1968.
- Milliken, Margaret and others, FIELD STUDY MANUAL FOR
OUTDOOR LEARNING. Minneapolis, Minnesota:
Burgess Publishing Company, 1968.
- Munzer, Martha E., and Paul F. Brandwein, TEACHING
SCIENCE THROUGH CONSERVATION. New York:
McGraw-Hill Book Company, Inc., 1960, 470 pp.
- National Association of Biology Teachers, MATERIALS FOR
TEACHING CONSERVATION AND RESOURCE-USE.
Danville, Illinois: Interstate Printers and
Publishers, Inc., 1955, 55 pp.

- National Association of Biology Teachers, Conservation Committee, HANDBOOK FOR TEACHING OF CONSERVATION AND RESOURCE-USE. Danville, Illinois: Interstate Printers and Publishers, Inc., 1958.
- Parsons, Donna L., Project Director, IDAHO, PL 89-10 ESEA Title III Project, School District 132, Caldwell, Idaho, September 1968.
- Pennsylvania Department of Education. Text by Eleanor H. Bennett. SCHOOL SITE DEVELOPMENT FOR CONSERVATION AND OUTDOOR EDUCATION. Bureau of General and Academic Education, Harrisburg, Pennsylvania, 1969.
- Shimada, Harry S. Jr., Project Director, OUTDOOR EDUCATION FOR IDAHO. American Falls School District 381, American Falls Idaho, ESEA Title III Project.
- Smith, Julian W. and others, OUTDOOR EDUCATION. Englewood Cliffs, New Jersey: Prentice-Hall Inc., June 1965.
- Stapp, INTEGRATING CONSERVATION AND OUTDOOR EDUCATION INTO THE CURRICULUM. (K-12). Minneapolis, Minnesota: Burgess Publishing Company, 1965.
- Shoman, Joseph J., MANUAL OF OUTDOOR CONSERVATION EDUCATION, National Audubon Society, 1130 Fifth Avenue, New York.
- United States Department of Agriculture, OUTDOORS U.S.A., The United States Printing Office. For Sale by Superintendent of Documents, Washington, D.C.
- United States Department of Agriculture, MOUNTAIN WATER, Intermountain Region, Forest Service, U.S. Department of Agriculture, May 1964.
- United States Department of Agriculture, CREATIVE LEARNING EXPERIENCES IN CONSERVATION, reprinted from Soil Conservation, 1968.
- United States Department of Agriculture, Forest Service, FORESTRY ACTIVITIES, The United States Printing Office. For Sale by the Superintendent of Documents, Washington, D.C.

United States Department of Agriculture, Forest Service,
 INFORMATION PACKET, U.S. Government Printing
 Office, Washington, D.C. Packet contains
 booklets as follows:

CONSERVATION ACTIVITIES FOR YOUNG PEOPLE
 FORESTRY, MANAGING AND USING FOREST AND
 RANGE LAND
 HIGHLIGHTS IN THE HISTORY OF FOREST CON-
 SERVATION
 HOW TO KNOW THE TREES OF THE INTERMOUNTAIN
 REGION
 MATERIALS TO HELP TEACH FOREST CONSERVATION
 PROTECTING THE FORESTS FROM FIRE
 RANGER 'RITHMETIC - for 1, 2, 3, and 7th
 grade teachers
 SAVING THE FORESTS
 SMOKEY BEAR'S STORY OF THE FOREST
 TREES OF THE FOREST - THEIR BEAUTY AND USE
 YOUR WATER SUPPLY AND FORESTS
 Maps, Teaching Aids, and Miscellaneous

United States Department of Agriculture, Soil Conserva-
 tion Service, MATERIALS ON SOIL AND WATER
 CONSERVATION. U.S. Government Printing
 Office, Washington, D.C. Packet contains
 booklets as follows:

AN OUTLINE FOR TEACHING CONSERVATION IN
 HIGH SCHOOLS
 AN OUTLINE FOR TEACHING CONSERVATION IN
 ELEMENTARY SCHOOLS
 CONSERVATION QUIZ - 64 Multiple choice
 Questions about soil and water conserva-
 tion
 KNOW YOUR SOIL
 KNOW THE SOIL YOU BUILD ON
 OUR NATIVE LAND
 OUR AMERICAN LAND
 SEDIMENT
 SOIL CONSERVATION AT HOME
 SOIL EROSION - THE WORK OF UNCONTROLLED
 WATER
 THE SOIL THAT WENT TO TOWN
 THE STORY OF PLANTS
 THE STORY OF SOIL
 THAT LAND DOWN THERE
 TEACHING SOIL AND WATER CONSERVATION - A
 classroom & field guide
 WATER INTAKE BY SOIL
 Miscellaneous pamphlets

United States Department of Agriculture, Forest Service,
CONSERVATION TOOLS FOR EDUCATORS, Pacific
Northwest Region Forest Service, 1968.

United States Department of Agriculture, Forest Service,
FORESTS IN UTAH. U.S. Forest Service Resource
Bulletin, INT-4, 1965.

Van der Smissen, Betty and Oswald H. Goering, NATURE-
ORIENTED ACTIVITIES. University Press, Ames,
Iowa, 1965.

Weaver, Richard L., MANUAL FOR OUTDOOR LABORATORIES.
Danville, Illinois: Interstate Printers and
Publishers, Inc., 1959, 81 pp.

Wilson, Carl L., and others, BOTANY. Third Edition.
Holt, Rinehart, and Winston, 1962, 1966.

FREE AND INEXPENSIVE MATERIALS AVAILABLE FOR TEACHING
CONSERVATION EDUCATION, Forests. Prepared by
Genevieve Cousins and Bonnie Mae Smith, Under
the Direction of Dr. George Ware, Director of
Conservation Education. Issued by the Louisi-
ana State Department of Education, North Loui-
siana Supplementary Education Center and
Natchitoches Parish School Board. October 1967.

ENVIRONMENTAL EDUCATION, Edited by Clay Schoenfeld,
University of Wisconsin, Madison Wisconsin.
(A new Journal of research and development in
Conservation Communications. Vol. 1, No. 1.
Published four times a year.

AUDUBON AIDS IN ANTURAL SCIENCE, (Pamphlet) National
Audubon Society, 1130 Fifth Avenue, New York.

**Special Charts by St. Regis. (Leaves, Trees, Etc.)
May be obtained from the St. Regis Paper Com-
pany, 180 East 42nd Street, New York City,
New York 10017.

**Reprints from Fish and Game Magazine. May be obtained
from the Utah Fish and Game Department, 1596
W. North Temple Street, Salt Lake City, Utah.

SELECTED NEWSLETTERS AND BULLETINS IN
CONSERVATION EDUCATION

R. LaMar Allred
Specialist in Science and Environmental Education

(Alphabetized by State)

Council for Planning and Conservation Newsletter

Mrs. Ellen Stern Harris
Executive Secretary
522 N. Foothill Road
Beverly Hills, CA 90210

Conservation Education Newsletter

Office of Conservation Education
Resources Agency
State of California
1416 9th Street
Sacramento, CA 95814

The Conservation Foundation Letter

The Conservation Foundation
1250 Connecticut Avenue, N.W.
Washington, D.C. 20036

A Bulletin on Conservation Education

The Conservation Foundation
1250 Connecticut Avenue, N.W.
Washington, D.C. 20036

Population Bulletin

Population Reference Bureau, Inc.
1755 Massachusetts Avenue, N.W.
Washington, D.C. 20036

Resources

Resources for the Future, Inc.
1755 Massachusetts Avenue, N.W.
Washington, D.C. 20036

Conservation News

National Wildlife Federation
1412 Sixteenth Street, N.W.
Washington, D.C. 20036

Conservation Report

National Wildlife Federation
1412 Sixteenth Street, N.W.
Washington, D.C. 20036

210

Soil Conservation

Soil Conservation Service
U.S. Department of Agriculture
Division of Public Documents
Washington, D.C. 20401

Bulletin

The Wilderness Society & the Sierra Club
729 Fifteenth Street, N.W.
Washington, D.C. 20005

Newsletter

Soil Conservation Society of America
Northern Illinois Chapter
1701 Towanda Avenue, P.O. Box 901
Bloomington, IL 61701

Open Lands Newsletter

Open Lands Project
53 West Jackson Boulevard
Chicago, IL 60604

Newsletter

Natural Resources Center
503 Oak Street
DeKalb, IL 60115

The Dupage Conservationist

Forest Preserve District of Dupage County
881 West St. Charles Road
Lombard, IL 60148

Journal of Soil and Water Conservation

Soil Conservation Society of America, Inc.
7515 Northeast Ankeny Road
Ankeny, IA 50021

Epic-Gram

Educational Project to Implement Conservation
The Public Schools of Westfield
22 Board Street
Westfield, MA 01085

Environmental Education News

Information and Education Division
Michigan Department of Natural Resources
Lansing, MI 48926

Mace Capsule

Minnesota Association for Conservation Education, Inc.
College of Education
University of Minnesota
Minneapolis, MN 55455

Open Space Action
Open Space Action Institute
145 W. 52nd Street
New York, NY 10022

Conservation Catalyst
The Belle W. Baruch Foundation
274 Madison Avenue
New York, NY 10016

Regional Conservation Education
Newsletter, Conservation Vista
Forest Service
U.S. Department of Agriculture
Milwaukee, WI 53203

REFERENCES

FIELDBOOK OF NATURAL HISTORY by E. Laurence Palmer;
McGraw-Hill Book Company, 8171 Redwood Highway, Novato,
CA 94947.

MEET THE NATIVES by M. Walter Pesman; Denver Botanic
Gardens, Inc., Denver, CO.

From the Peterson Field Guide Series from Houghton Mif-
flin Company, Palo Alto, CA

- a. A FIELD GUIDE TO WESTERN BIRDS by Roger Tory
Peterson
- b. A FIELD GUIDE TO THE MAMMALS by William Henry
Bury
- c. A FIELD GUIDE TO ROCKY MOUNTAIN WILDFLOWERS by
John J. Craighead
- d. A FIELD GUIDE TO INSECTS by Donald J. Borror
- e. A FIELD GUIDE TO TREES & SHRUBS by Petrides

WHAT INSECT IS THAT by John DeWaard; American Education
Publications, Education Center, Columbus, OH 43216.

INSECT COLLECTING MANUAL by Dr. Richard L. Post; Depart-
ment of Entomology, Agricultural Experiment Station,
North Dakota State University, ND.

Books from the How to Know Series, order from William C.
Brown Company Publishers, Dubuque, IA 52001.

- a. HOW TO KNOW THE AQUATIC PLANTS by Prescott
- b. HOW TO KNOW THE WEEDS by H.E. Jaques
- c. PLANT FAMILIES - HOW TO KNOW THEM by H.E. Jaques
- d. HOW TO KNOW THE FALL FLOWERS by Mabel Jaques
Cuthbert
- e. HOW TO KNOW THE GRASSES by R.W. Pohl
- f. HOW TO KNOW THE PROTOZOA by T.L. Jahn
- g. HOW TO KNOW THE IMMATURE INSECTS by Chu

SCIENCE MATERIALS: PREPARATION AND EXHIBITION FOR THE
CLASSROOM by Gordon G. Pond, William C. Brown Company
Publishers, Dubuque, IA 52001.

FIELD STUDY MANUAL FOR OUTDOOR LEARNING by Margaret
Milliken; Burgess Publishing Company, 426 South Sixth
Street, Minneapolis, MN 55415.

FOSSILS, A GUIDE TO PREHISTORIC LIFE by Frank H.T. Rhodes,
Golden Press, New York, NY.

A GUIDE TO THE STUDY OF FRESH WATER BIOLOGY by Needham and Needham; Holden-Day Inc., San Francisco, CA.

FIELDBOOK OF PONDS AND STREAMS by Ann Morgan; G.P. Putnam's Sons, New York, NY.

THE NEW FIELD BOOK OF FRESHWATER LIFE by Elsie G. Klots; G.P. Putnam's Sons, New York, NY.

WILDLIFE COMMUNITIES by Clarence J. Hylander, Houghton Mifflin Company.

SPORTSMAN GUIDE TO GAME ANIMALS by Leonard Lee Rue; Outdoor Life Books of Harper and Row, New York, 1970.

ECOLOGY AND FIELD BIOLOGY by Robert L. Smith, Harper & Row, New York, 1966.

WILDLIFE OF NORTH ROCKY MOUNTAINS by William Baker, et al, Naturegraph Company, Healdsburg, California, 1961.

N. A. TREES, Richard J. Preston, Jr. MIT Press, Cambridge, Massachusetts, 1966, Revised Edition.

MAN AND THE ENVIRONMENT, Education Research Council of America, Houghton Mifflin Company, Boston, 1971.

CHAPTER IV - RESOURCE MANAGEMENT

"I recognize the right and duty of this generation to develop and use our natural resources, but I do not recognize the right to waste them, or to rob by wasteful use, the generations to come after us."

--President Theodore Roosevelt

Many of the environmental concerns that trouble Americans today rise from the need to call upon a fixed land base to support a growing demand for water, food, fiber, chemicals, wood products, and minerals. All of these must come from the land. All of the land we will ever have is already here, yet the demand for these products keeps increasing. Environmental impacts of people on the land are inevitable, but thoughtful resource management can lessen them. This section describes a resource management program employed by the U.S. Forest Service in the Ouachita National Forest, located in Oklahoma and Arkansas.

Resource Management in the Ouachita National Forest

The job of forest management today is to harmonize the many different uses of forest land, blending them together to multiply the values produced from the land to provide for a wide range variety of human needs. The use of forest land must be planned wisely to protect the basic integrity of the forest resource, while trying to

increase the land's output. If done skillfully, one can often be made to serve another use jointly.

The Ouachita National Forest was established in 1907 by Presidential proclamation and is managed under the Multiple Use Yield Act of 1960. This act represents congressional affirmation of the established policy of the U.S. Department of Agriculture to manage the resources of the National Forests for multiple use purposes.

Growing Trees

Under proper management and with a balanced consideration for all uses, the growing of trees increases in value each year, thus timber harvested to help meet the nation's demands for wood products contributes to the national economy. Many commercial operators, both large and small, depend on National Forest timber for the wood products they need. Contract requirements for cutting and logging timber are designed to sustain the resource and, at the same time, protect and enhance watershed, wildlife and recreation. To ensure the future production of timber, the Forest Service manages the production of seeds through seed orchards, extracting these from cones. Seed extracted from these cones are stored and provide superior shortleaf pine seedlings for planting.

Applying Esthetics to Forestland Management

Landscape architects work with resource managers applying the landscape management system which deals with the harmony or disharmony among all parts of the Forest, the landforms, vegetations, structures, air and water.

All major activities such as timber harvesting, road construction, recreation development, utility installation, and mineral exploration require landscape management analysis.

To achieve visual harmony of the landscape, forest managers evaluate physical and ecological constraints, socioeconomic factors, and design requirements.

Taking advantage of landscape features, vegetation may be removed, modified or added in way that will reduce the visual impact on the landscape and the contrast between resource activities and their surroundings.

Recreation

One of the outstanding attributes of a well-managed forest is providing recreation opportunities for the public. A well-managed forest, such as the Ouachita, provides both products and pleasure at the same time. Recreational opportunities include camping, picnicking, swimming, fishing, hunting, boating, bird watching, photography, riding, hiking.

Water Resource Management

A primary purpose of the National Forests, as directed by Congress in 1897, is to secure favorable conditions of water flow. All forest uses are adjusted and keyed to the continued production of clear, clean water for recreation, municipal, industrial and agricultural uses.

Estimated annual rivers; the Ouachita, Kiamichi, Little Missouri, Cossatot, Maumelle, Fourche la Pave and Caddo begin in the Ouachita Forest. Downstream, the cities of Hot Springs, Danville, Glenwood, and Mount Ida take drinking water from streams originating in the Ouachita National Forest watersheds.

Impoundments within or adjacent to the forest furnish water for the cities of Little Rock, Waldron, and Mena.

To maintain water quality and soil productivity while keeping land uses within soil capabilities and limitations, soil scientists conducted a soil resource inventory on 74,000 acres.

Wildlife Management

Protection, management and development of wildlife habitat on the Ouachita Forest land is the responsibility of the U.S. Forest Service. Responsibility for managing the fish and wildlife populations rests with the states of Oklahoma and Arkansas. Working with the states, the forest service applies the service of growing and

harvesting wildlife under the featured species concept, as determined by habitat studies. Habitat improvements to date include 600 wildlife ponds and 500 wildlife openings. Currently, 60,000 acres are coordinated with timber management for specific game species.

Plans call for cooperating with the Oklahoma Department of Wildlife Conservation and the Arkansas Game Commission to place all forest lands under wildlife management.

Cattle Grazing

The Forest Service coordinates woodland grazing with other Ouachita Forest uses thus helping sustain a high production of forage. Established grazing seasons protect other resources and keep use and production in balance.

Fire Prevention

Striving to prevent the waste of the Nation's natural resources which results from wildfires on both public and private lands, the Cooperative Forest Fire Prevention Program is conducted jointly with State Foresters and the Advertising Council.

Forest fire prevention advertising reached thousands of people this year in Arkansas and Oklahoma through radio and television announcements, posters, motion pictures, press releases, feature articles, exhibits, pamphlets, bookmarks, stickers, calendars, badges and stamps.

Fire prevention and protection measures, including aerial detection and attack, help to reduce the number of fires and the number of acres burned.

Environmental Engineering

Environmental engineering guides the use and development of natural resources which involve the Ouachita solid waste disposal, road construction and maintenance, prevention, control and abatement of air and water pollution.

Forest management includes the operation of a waste system, and collection of waste disposal in two sanitary landfills; construction of 95 miles of road to provide access for hunters and sightseers as well as timber harvest, fire protection, and management; repairing flood damage to bridge crossings and drainage structures; pollution abatement at Cedar Lake Recreation Area; and maintenance of 100 bridges and approximately 1,900 miles of roads for general public use of the forest.

Environmental Education, Human Resource Development, and Information

Environmental Education provides people with relevant and significant learning experiences to aid them in making intelligent environmental decisions in everyday life.

Workshops in Arkansas and Oklahoma involved over 5,000 people in learning how to live and use their environment.

The U.S. Forest Service cooperates with institutions of higher education to provide environmental education programs for the public. These programs, in addition to the usual "walk in", self-directed interpretative centers, offer opportunities for a varied clientele to derive maximum environmental education benefits from an enticing environment.

A program conducted in July, 1977, provided visiting families with organized "hands on" experiences, which stressed human and environmental interactions.

The Youth Conservation Corps Program offered an 8-week residential program of conservation work, education and recreation for 38 young men and women between the ages of 15-18.

Job Corps offers young people training in skills which will enable them to find work in jobs with a future, while also developing their reading and arithmetic skills. These jobs make lasting contributions to the protection and development of the National Forest.

While accommodating 176 Corpsmen 16 through 21 years of age, Ouachita CCC constructed a variety of essential National Forest operating facilities, mechanics and general maintenance. Instructors from labor unions in the building trades play a major role in training and

finding jobs for Corpsmen in carpentry, painting, and plastering.

The aim of the Forest Information and Education Program is to inform.

Forest specialists fulfill thousands of requests for factual conservation information, material and publications. Enlisting the interest and aid of conservation groups, civic organizations, educators, youth groups, business and professional groups, and women's organizations, specialists also assisted these groups in conservation programs and project planning.

Cooperating with individuals, organizations and other public agencies whose goals are compatible, the Forest utilized these media to build and maintain good working relations.

Future Planning

In 1973, the Ouachita National Forest was divided into 12 planning units, ranging in size from 43,000 to 291,000 acres, and encompassing watersheds with similar physical characteristics. Plans developed for these units tell what, where, when and how resources will be managed for 10 years.

Scheduled for completion in 1979, the unit planning process includes identifying land capability, setting objectives, defining alternate ways of meeting

the objectives, and choosing the alternative that best protects the environment while serving the public need. The process also offers the public opportunities to participate in the planning and comment on published environmental statements.

Wastage of natural and human resources, either by neglect or destruction, robs society of its rightful potentialities for better living. In order to develop and conserve our Nation's resources, it is imperative that effective models of resource management be designed and implemented. The author is indebted to Mr. Alvis Owen, Forest Supervisor, Ouachita National Forest, for much of the information presented on Forest Management.

GOVERNMENT AGENCIES, PROFESSIONAL
GROUPS AND CITIZEN ORGANIZATIONS *

This section contains an alphabetized and annotated listing of selected environmental agencies and organizations. Additional information can be obtained by contacting the particular organization. The bibliography is selective and is slanted towards groups with environmental materials of interest to educators. For a more complete guide, refer to the National Foundation for Environmental Control's Directory of Environmental Information sources.

* Credit for this information is given to Dr. Jerry F. Howell, Director of Environmental Studies and Ms. Jeanne S. Osborne, Morehead State University, Morehead, KY.

GOVERNMENT AGENCIES

Atomic Energy Commission
Washington, D.C. 20545
or

Box 62
Oak Ridge, Tennessee 37830

This independent governmental agency has control over all activities promoting nuclear energy. They have many available publications on radiation and its hazards.

Bureau of Land Management
Department of the Interior
18th and C Streets, NW
Washington, D.C. 20240

This agency is concerned primarily with range management in the western states. They publish Our Public Lands, a quarterly.

Bureau of Mines
Department of the Interior
18th and C Streets, NW
Washington, D.C. 20240

Bureau of Outdoor Recreation
Department of the Interior
18th and C Streets, NW
Washington, D.C. 20240

This agency is concerned with outdoor recreation through a research and granting program, many available publications.

Bureau of Reclamation
Department of the Interior
18th and C Streets, NW
Washington, DC 20240

A water reclamation agency, this bureau has an executive technical publications file.

Council on Environmental Quality
722 Jackson Place, NW
Washington, D.C. 20006

Responsible to the President, this Council approves and disapproves projects requiring an environmental impact statement. Although possessing no veto powers, the Council is influential in helping to fund or defund projects.

Department of Agriculture
14th Street and Jefferson Drive, SW
Washington, D.C. 20250

Many branches of this Department (all at different addresses) are environmentally involved. Among them are the Agricultural Stabilization and Conservation Service, and the Forest Service.

Ecological Information and Analysis Center
Battelle Memorial Institute
505 King Avenue
Columbus, Ohio 43201

This center collates, stores and disseminates environmental information.

Environmental Protection Agency
Waterside Mall
401 M Street, SW
Washington, D.C. 20460

Southeast Region IV
1421 Peachtree Street NE
Atlanta, Georgia 30309

The ultimate U.S. governmental organization, EPA was formed to monitor, create and set environmental standards, to assist state and local governments, and to perform and provide funds for research. Every program within this agency is built around some environmental concern, and they are a major source of environmental education materials, most of it free. For the story of EPA, ask for their Toward a New Environmental Ethic.

Fish and Wildlife Service
Department of the Interior
18th and C Streets, NW
Washington, D.C. 20240

The Bureau of Sport Fisheries and Wildlife is an experienced agency dealing with the conservation and protection of fish and wildlife. They also support research through their various divisions and have many available publications.

Forest Service
South Agriculture Building
12th and Independence Avenue, SW
Washington, D.C. 20250

c/o Director of Information and Education,
South Agriculture Bldg.
12th & Independence Ave., SW
Washington, D.C. 20250

This organization is a long-standing agency directly involved in the practical conservation of natural resources. They publish many technical and general reports; write for a list.

Geological Survey
Department of the Interior
18th and F Streets, NW
Washington, D.C. 20242

Although minerals are a primary concern of this agency, they are also responsible for monitoring national water resources. Many publications, primarily on the physical characteristics of their monitored waterways and resources, are available.

National Environmental Research Center
Environmental Protection Agency
Cincinnati, Ohio 45268

This laboratory and others of its kind perform basic environmental research. A division of the EPA, they offer help in a variety of ways.

National Oceanic and Atmospheric Administration
6010 Executive Blvd.
Rockville, Maryland 20852

An agency of the Department of Commerce, NOAA is concerned with all environmental aspects of the ocean and adjacent areas.

Oklahoma Department of Agriculture
State Capitol Building
Oklahoma City, Oklahoma 73105

This department provides information on environmental management and its relationship to agriculture.

Oklahoma Conservation Commission
20 State Capitol Building
Oklahoma City, Oklahoma 73105

This commission is active in promoting educational programs and providing conservation and environmental information to educators and other interested publics.

Oklahoma Department of Education
Oliver Hodge Education Building
2500 North Lincoln Blvd.
Oklahoma City, Oklahoma 73105

This department provides educators and other interested public with information on environmental education curriculum and programs.

Oklahoma State Department of Health
Northeast 10th and Stonewall
Oklahoma City, Oklahoma 73105

This department provides information and films relative to health and the environment.

Oklahoma Department of Energy
4400 Lincoln Blvd.
Oklahoma, Oklahoma 73105

This department provides information on energy and the environment.

Oklahoma Department of Pollution Control
Northeast 10th and Stonewall
Oklahoma City, Oklahoma 73105

The Department of Pollution Control can provide information on pollution control methods employed in the state.

Oklahoma Department of Tourism and Recreation
500 Will Rogers Memorial Office Building
Oklahoma City, Oklahoma 73105

Information may be obtained concerning a wide range of recreation opportunities in the state. The Department publishes Oklahoma Today.

Oklahoma Department of Wildlife Conservation
1801 North Lincoln Blvd.
Oklahoma City, Oklahoma 73105

This department is responsible for wildlife management in the state. Outdoor Oklahoma is published monthly by the department.

Tennessee Valley Authority
New Sprinkle Building
Knoxville, Tennessee 37902

The Nation's largest federally supported water resource agency concentrated in one river basin, TVA supports an Environmental Education Branch (Norris, Tennessee 37828) and an Environmental Education Center (Land Between the Lakes, Golden Pond, Kentucky 42231).

CITIZEN'S ORGANIZATIONS & PROFESSIONAL GROUPS

American Association for the Advancement of Science
1515 Massachusetts Avenue, NW
Washington, D.C. 20005

This association is the parent organization of all scientific groups and agencies.

American Association of Nurserymen
835 Southern Building
Washington, D.C. 20005

This association is a organization of various members of the nursery profession, and has produced several pamphlets concerned with trees, shrubs, and flowers.

American Chemical Society
1155 16th Street, NW
Washington, D.C. 20036

This is a large organization which publishes many books and journals, including Environmental Science and Technology. ES and T is a technical journal devoted to pollution control.

Aluminum Association
420 Lexington Avenue
New York, New York 10017

This group publishes several environmental publications and are interested in aluminum recycling.

American Forestry Association
1319 18th Street, NW
Washington, D.C. 20036

Dedicated to the wise use of American forests, this organization has literature available describing this goal. An introductory pamphlet, Meet the American Forestry Association, is free.

American Geological Institute
2201 M Street, NW
Washington, D.C. 20037

This organization is a amalgamation of several professional geology, geochemical, and geophysical societies. They publish Geotimes, and are responsible for several bibliographies and reports.

American Institute of Biological Sciences
3900 Wisconsin Avenue, NW
Washington, D.C. 20016

This is a major professional organization for biologists. They have educational and library programs, in addition to sponsoring many publications and activities.

American Lung Association
1740 Broadway
New York, New York 10019

This is the new name of the tuberculosis and respiratory disease associations. They publish many free air pollution publications.

American Museum of Natural History
Central Park West at 79th Street
New York, New York 10024

They are the publishers of the slickpaper magazine, Natural History, and are concerned with all forms of environmental degradation. They promote research and education, both environmentally slanted.

American Nature Study Society	
Milewood Road	1144 East Third Street
Verbank, New York 12585	Salt Lake City, Utah 84102

Started in 1970, this organization is devoted to general environmental education. They publish Nature Study Tips.

American Public Health Association
1740 Broadway
New York, NY 10019

A professional group of medically associated personnel devoted to the promotion of public health, including citizen protection from environmental diseases.

American Society of Landscape Architects
1750 Old Meadow Road
McClellan, Virginia 22101

The professional organization of U.S. landscape architects.

American Society of Naturalists
Department of Zoology
University of Texas
Austin, Texas 78712

A group of amateur and professional naturalists dedicated to the advancement of natural history knowledge.

Association of American Geographers
1146 16th Street, NW
Washington, D.C. 20036

1710 16th Street, NW
Washington, D.C. 20009

A professional organization formed to further geographical education and research.

Association of Interpretive Naturalists
2240 West Buno Road
Milford, Michigan 48042

Exhibits and programs are the specialties of this group. They also support the preservation of natural areas.

Audubon Naturalist Society of the Central Atlantic States, Inc.
8940 Jones Mill Road
Chevy Chase, Maryland 20015

Natural resource conservation, or ornithology, and environmental education are topics of interest for this group. They publish the Atlantic Naturalist.

Citizens Against Noise
2729 West Lint Avenue
Chicago, Illinois 60645

This 1970 organization is very active against excessive noise.

Citizens for Clean Air
502 Park Avenue
New York, New York 10022

Public education in air pollution matters is the goal of this organization.

Citizens League Against the Sonic Boom
19 Appleton street
Cambridge, Massachusettes 02138

This is an organization formed to combat airplane sonic booms, lately the supersonic transport models.

Committee for Environmental Information
438 North Skinner Blvd.
St. Louis, Missouri 73130

This group, associated with the Scientists Institute for Public Information, publishes a major environmental periodical, Environment. Supportive of research and education, they issue scientific environmental matters.

Conservation Education Association
1250 Connecticut Avenue, NW
Washington, D.C. 20036

Organized in 1947, this group is concerned with public education, primarily in school systems. They publish many timely articles, including a newsletter and occasional bibliographies.

Conservation Foundation
1717 Massachusetts Avenue, NW
Washington, D.C. 20036

This organization is primarily concerned with the land use aspect of environmental concerns. They monitor legislation and the activities of governmental agencies, in addition to publishing many resources concerning their activities.

Defenders of Wildlife
2000 N. Street, NW
Washington, D.C. 20036

This group, publishers of Defenders of Wildlife News, was founded in 1925 as an organization devoted to the humane treatment of trapped animals. Now it has expanded to include research activities.

Ducks Unlimited
Box 66300
Chicago, Illinois 60666

This organization is an old line sportsmen's group dedicated to extending the range of all species of ducks and other wildlife by buying and restoring their breeding grounds.

Ecological Society of America
Department of Botany
University of North Carolina
Chapel Hill, North Carolina 27514

The publishers of Ecology and Ecological Monographs, this old professional group has been at the forefront of basic ecological research for years. It has more than 4,000 members, including professional ecologists and educators.

Ecology Action
Box 9334
Berkeley, California 94709

Founded in 1968, this group has action as a priority on several issues. It is concerned with community programs and urban problems.

Ecology Center Communications Council
Box 21072
Washington, D.C. 20009

The purpose of this organization is to provide a network of communications between U.S. ecology centers.

Ecology Center of Southern California
2315 Westwood Blvd.
Los Angeles, California 90024
or

Box 24382
Los Angeles, California 90024

This is a non-profit organization which provides free information, references, research and referral services on ecological matters primarily for California, but they produce a materials list. Free information available for a self addressed envelope.

Environmental Action, Inc.
1346 Connecticut Avenue, NW
Room 731
Washington, D.C. 20036

An action organization springing from the first Environmental Teach In, Environmental Action has recently begun fervent lobbying activities on Capitol Hill. Effective and unrelenting, they publish Environmental Action, a montly report.

Environmental Defense Fund, Inc.
162 Old Town Road
East Setauket, New York 11733

This respected group, founded in 1967, takes polluters, government agencies, and environmental degraders to court, often succeeding. It is made up of lawyers and scientists, serving with little or no salary.

Oklahoma Association of Conservation Districts
Wallace Denny, President
1002 North Wentz
Guthrie, Oklahoma 73044

Promotes conservation in local communities; very helpful resources for educational and environmental programs

Oklahoma 4-H Clubs
Oklahoma State Extension
Stillwater, Oklahoma 74074

Youth Development, Environmental Awareness and Home Environment, contained in publication on Youth Development project.

Environmental Education Group
1543 North Martel
Los Angeles, California 90046

A very active group associated with a sister organization, Environmental Alert, this group has published many public interest reports in the past few years. Mainly concerned with energy alternatives, these publications offer very honest environmental appraisals.

Forest History Society
Forest History Center
University of California at Santa Cruz
Santa Cruz, California 95060

A coalition of various professionals interested in the history of American forests.

Friends of Animals, Inc.
11 West 60th Street
New York, New York 10023

A nationwide humane organization, Friends support many nationwide programs, especially those involving cruelty to animals.

Friends of the Earth
529 Commercial Street
San Francisco, California 94133

Publishers, with Ballantine Books, of a series of nature works, Friends of the Earth is an organization dedicated to legislative concerns and legal action. Active in recent years, this group is one of many strong voices in the anti-dam movement.

Garden Club of America
598 Madison Avenue
New York, New York 10022

An old line outdoor group with regional affiliates, the Garden Club has a conservation education program and an environmental packet service.

Geoscience Information Center
c/o American Geological Institute
2201 M Street, NW
Washington, D.C. 20037

A group of scientific professionals, librarians and editors who are involved in information dissemination and geoscience recruitment activities.

Glass Container Manufacturers Institute
330 Madison Avenue
New York, New York 10017

The institute supports research in the development of glass containers, including factors involved in recycling.

Good Outdoor Manners Association
Box 7095
Seattle, Washington 98133

Founded in 1959, this group is concerned with outdoor and recreational abuse. Their materials support the use of their symbol, "Howdy," a raccoon. Write for their free Lecture Program and Educational Aids.

Institute of Environmental Sciences
940 East Northwest Highway
Mt. Prospect, Illinois 60056

This organization is a technical society of environmental engineers and managers interested in environmental simulation. They publish a technical Journal and annual Proceedings.

International Association for Advancement of
Earth and Environmental Sciences
Department of Earth Science
Northeastern Illinois University
Bryn Mawr at St. Louis Avenues
Chicago, Illinois 60659

A scientific group involved in publishing and disseminating environmental information. For details, write for An Invitation to Join IAAEES.

Izaak Walton League of America
1800 North Kent Street, Suite 806
Arlington, Virginia 22209
or
719 13th Street, NW
Washington, D.C. 20005

This is a conservation-minded membership organization founded in 1922 and devoted to maintaining a quality environment. They are especially concerned with outdoor recreation. The League has a number of available publications, including the Izaak Walton Magazine, and will furnish speakers on request. For a description of their activities and policies, write for The Turning Point and Environmental Blueprint for the 70's, a 31 page policy description.

John Muir Institute for Environmental Studies
415 Pacific Avenue
San Francisco, California 94133

Associated with Friends of the Earth, this institute is research oriented and concerned with nationwide issues.

Keep America Beautiful, Inc.
99 Park Avenue
New York, New York 10016

An industry-supported organization long opposed to litter. This group sponsors many nationwide cleanup campaigns and other activities. Their literature has been cited many times in this bibliography.

Lake Erie Environmental Studies
State University College of New York
Fredonia, New York 14063

An academic institution, this center has published a Directory of Organizations Concerned With Environmental Research.

League of Conservation Voters
917 15th Street, NW
Washington, D.C. 20005

Another associate of Friends of the Earth, this group informs the public on the environmental record of congressmen.

League of Women Voters of the United States
1730 M Street, NW
Washington, D.C. 20036

This group, while presenting and discussing many national issues, has much information on such environmental topics as food, population, and pollution.

Massachusetts Audubon Society
 South Great Road
 Lincoln, Massachusetts 01773

The oldest state Audubon group, this chapter is particularly active, especially in the field of environmental education. They operate the Hatheway School of Conservation and the Conservation Education Center. A major publication is their Aids to Environmental Education in several volumes, covering the grades from kindergarten to the sophomore level in college. This annotated bibliography has been cited many places in this work.

National Academy of Sciences
 2101 Constitution Avenue, NW
 Washington, D.C. 20418

This is an internationally acclaimed organization of engineers and scientists which publishes several journals and books each year, many of them dealing with environmental matters.

National Association of Biology Teachers
 1420 N. Street, NW
 Washington, D.C. 20005

This is a professional organization of 10,000 members (mostly teachers of biology) which publishes The American Biology Teacher.

National Association of Soil and Water Conservation Districts
 1025 Vermont Avenue, NW
 Washington, D.C. 20005

The purpose of the established soil conservation districts is long range-planning towards the development and conservation of natural resources, especially soil and water.

National Audubon Society
 1130 5th Avenue
 New York, New York 10028

or 1511 K Street, NW
 Washington, D.C. 20005

Since 1905, this active environmental organization has been at the forefront of environmental controversies. Originally an organization for the study of birds, the Audubon Society is now engaged in much broader issues. They have a wealth of environmental education aids and advice, whether it be for one classroom or an entire school system. They also publish the acclaimed Audubon magazine.

National Center for Resource Recovery, Inc.
1211 Connecticut Avenue, NW
Washington, D.C. 20036

A recycling group, the center publishes many useful publications and aids, including National Organizations in Solid Waste Management, a listing of involved groups and agencies.

National Education Association
1201 16th Street, NW
Washington, D.C. 20036

This is the national professional group of educators devoted to all aspects of education nationwide. They have published several environmental education aids, including a List of References on Conservation Education.

National Foundation for Environmental Control, Inc.
151 Tremont Street
Boston, Massachusetts 02111

Founded in 1970, NFEC has the dissemination of environmental knowledge as its first priority. It has published a comprehensive compilation of informational sources, the Directory of Environmental Information Sources.

National Geographic Society
Box 1640
Washington, D.C. 20013

A popular membership organization, this group publishes National Geographic magazine, a national standard for years. The magazine has changed its basic format to keep with the tempo of the times. For a description of the Society, write for the flyer, The National Geographic Society.

National Parks and Conservation Association
1701 18th Street, NW
Washington, D.C. 20009

Dedicated primarily to the preservation of the national park and monument system, this group publishes National Parks and Conservation magazine. Recently they have become more active in the entire environmental field.

National Park Service
U.S. Department of the Interior
Washington, D.C. 20009

As one of the nation's guardians of public park and monument lands, the National Park Service has a prolific amount of materials available. They also have many programs designed to aid school systems and citizen groups. Among the most relevant educational programs are the NEED program, developed to encourage environmental education in the elementary school; the STEP program, developed on a peer teaching basis for secondary students; and the NESA program, designed to designate environmental study areas for students and groups. For a complete description of programs, see "National Park Service Educational Programs," an article from Volume 44, Number 274 (1970) of National Parks and Conservation Magazine.

National Technical Information Service
5285 Port Royal Road
Springfield, Virginia 22151

This is an environmental dissemination organization within the Department of Commerce that provides reprint services and a periodical covering their environmental reprints.

Office of Ecology
Smithsonian Institute
10th Street and Constitution Avenue, NW
Washington, D.C. 20560

This office coordinates the Smithsonian Ecology Program which places personnel in overseas jobs.

Office of Water Resources Research
Department of the Interior
18th and C Streets, NW
Washington, D.C. 20204

This branch is engaged in water resources research and can provide information on a variety of projects.

Planned Parenthood - World Population
810 7th Avenue
New York, New York 10019

PPWP, founded in 1921, is responsible for most of the birth control programs in this and other countries. It supports clinics and population research, along with providing educational materials.

Public Land Cleanup
Room 5639
Interior Building
Washington, D.C. 20240

This agency of the Department of the Interior is responsible for the Johnny Horizon program.

National Recreation and Park Association
1700 Pennsylvania Avenue, NW
Washington, D.C. 20006

This is a large organization of recreation specialists of all kinds who publish the Parks and Recreation magazine.

National Speleological Society, Inc.
2318 North Kenmore Street
Arlington, Virginia 22201

This group is concerned with the ecology of caves and supports research into their mysteries.

National Wildlife Federation
1412 Sixteenth Street, NW
Washington, D.C. 20036

Founded in 1936, NWF is the largest conservation organization in the world. It has many state affiliates and has a plethora of programs designed to help individuals and groups. A statement of policy, This We Believe, is an available flyer. NWF also supports research and is very active in publishing. They produce National Wildlife, International Wildlife, and the free Conservation News and Conservation Report. For children, they publish the very popular Ranger Rick's Nature Magazine.

Natural Resources Defense Council, Inc.
36 West 44th Street
New York, New York 10036

This council is involved in matters concerning environmental law.

Nature Conservancy
1800 North Kent Street, Suite 800
Arlington, Virginia 22209

Since 1917 this group's main purpose has been to acquire lands for continual preservation. They are also involved in education and research and publish the Nature Conservancy News.

Population Council
245 Park Avenue
New York, New York 10017

This council is involved in population research and training. It also maintains a technical assistance staff and population information clearinghouse. They publish studies in Family Planning and Population Chronicle.

Population Crisis Committee
1730 K Street, NW
Washington, D.C. 20006

This group was organized in 1965 and are the publishers of Population Crisis.

Population Reference Bureau, Inc.
1755 Massachusetts Avenue, NW
Washington, D.C. 20036

Since 1929 this group has been monitoring world population and has been issuing facts through their publications, Population Bulletin and Population Profiles and Selections.

Public Interest Research Group
1025 15th Street, NW
Washington, D.C. 20036

This group, founded by Ralph Nader, has several chapters nationwide. Although they have many interests, environmental issues are a top priority.

Resources for the Future, Inc.
1755 Massachusetts Avenue, NW
Washington, D.C. 20036

A publishing group, this organization is research oriented, although they are active educationally.

Save the Redwoods League
Room 605
114 Sansome Street
San Francisco, California 94104

A special interest group devoted to preserving the coastal redwoods.

Scientists Institute for Public Information
30 East 69th Street
New York, New York 10021

The professional group which publishes Environment magazine.

Sierra Club
220 Bush Street
Room 1050 Mills Tower
San Francisco, California 94104

Publishers of the Sierra Club Bulletin, this old line conservation-preservation organization was founded in 1892 by John Muir. Active and vociferous, this club fights against blind progress, especially in the halls of Congress. Supporting a large membership, the Sierra Club has its own Foundation and is very effective in its activities. Much of their philosophy is revealed in their publications; write for a list.

Soil Conservation Society of America
7515 Northeast Ankeny Road
Ankeny, Iowa 50021

This group of soil and water conservationists produce a number of environmental publications, many of which are cited in this bibliography. They also offer scholarships to college students.

Sport Fishing Institute
Suite 503
719 13th Street, NW
Washington, D.C. 20005

The SFI Bulletin is the house organ promoting the conservation of fish and other aquatic resources.

Trout Unlimited
4260 East Evans Avenue
Denver, Colorado 80222

Dedicated to the proliferation of trout and clean streams, this membership organization lobbies within governmental circles to accomplish their goals. They also publish Trout Magazine.

Water Pollution Control Federation
3900 Wisconsin Avenue, NW
Washington, D.C. 20016

Consisting of more than 16,000 members, this water engineering group is interested in water pollution control. They promote every phase of technical pollution control. They publish the Journal of WPEC.

Western Wood Products Association
700 Yeon Building
Portland, Oregon 97204

This is an association of lumber manufacturers. They publish many free education aids, including a packet of environmental materials.

Wilderness Society
729 15th Street, NW
Washington, D.C. 20005

Devoted to wilderness preservation, the Wilderness Society promotes research and wildland protection. They publish the Outdoor News Bulletin.

World Wildlife Fund
910 17th Street, Suite 728
Washington, D.C. 20006

The chief organization designed to protect rare and endangered species, the Fund, affiliated with the International Union for Conservation of Nature and Natural Resources of 1110 Morges, Switzerland, helps to publish the Data Books, official chronicles of the world's endangered species.

Zero Population Growth
4080 Fabian Way
Palo Alto, California 94303

This group has been instrumental in lobbying for, publicizing, and distributing information about population issues. An unrelenting organization, they publish the National Reporter.

Thomas D. Johnsten
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CHAPTER V - OUTDOOR CLASSROOMS

Outdoor Classrooms - What Are They?

I'd like to define outdoor classrooms by describing what they are not. They are not: just undisturbed natural areas, just trails with carefully labeled points of interest, just a place where resource speakers come to teach conservation lessons, or a place where adults get together and decide what to install for the students. Outdoor classrooms may contain almost all of the above, but that's not all they should be.

Outdoor classrooms begin when a teacher takes children outdoors and asks them to locate a problem on the school site. She follows this by asking the children what to do about it. At the moment the children start to think and to respond, the outdoor classroom has begun.

Outdoor classrooms are unique, outdoor environmental learning laboratories created by children for children. They serve as extensions of the indoor classroom. Outdoors, the books become alive and children experience highly motivated learning experiences thru the use of their senses of feeling, tasting, touching, smelling, seeing, and hearing. As the children create their

classroom and then use it, they begin to see patterns and relationships between the books, themselves, and their environment, and thus they have a greater desire to learn.

It doesn't matter whether the outdoor classroom is forty acres of rambling meadow, forest, stream area, a gravel infested bermuda grass lot, or a few square feet of soil beyond the black top under the fire escape, students can acquire the same basic understandings of soil-water-air-light-plant relationships and the need for intelligent management of all our natural resources.



Outdoor Classrooms - Why have them?

It takes time, work, and planning to have an outdoor classroom. Why have them; is it worth it?

Most teachers will tell you that if they have highly motivated students, teaching is a great experience! They'll also tell you that with television, automobiles, stereos, and all the many distractions children have at their disposal almost constantly, motivation with books becomes increasingly difficult. This is especially true where books are the only mode for learning. Bored students "turn off" the teacher, and learning is minimal. Motivating students is an art all teachers would like to develop to the maximum. Outdoor classrooms provide them with the opportunity to do so.

Teachers worry that children are not learning to read, write, compute, and develop the skills necessary for their survival after formal schooling ends. In their effort to "teach" these basic skills, they sometimes neglect helping the children realize "why" it is important for them to learn these skills and "how" they will be useful.

Teachers also have a problem with segmented learning with children. Frequently children go to five or six teachers daily for study in different subject areas. Each teacher is determined to "teach" her subject with little or no reference to any other subject or discipline. The children fail to see the patterns and

relationships between the subject areas and especially important, they fail to see how all the subjects they study are part and parcel of the natural laws thru which they (the students) survive. There's simply no ecology in this type of learning experience.

Outdoor classrooms offer unlimited opportunities for teachers to solve the problems discussed above. In the creation of an outdoor classroom, students must read to get information of "how to", write to get "resource materials" to read, compute to "figure out how much money they will need", how much space for this part or that part, and reason to figure out how to get all the people they need help from to give it. This ties quite naturally to how things are out in the adult world where they are headed. They see a reason for learning basic skills!

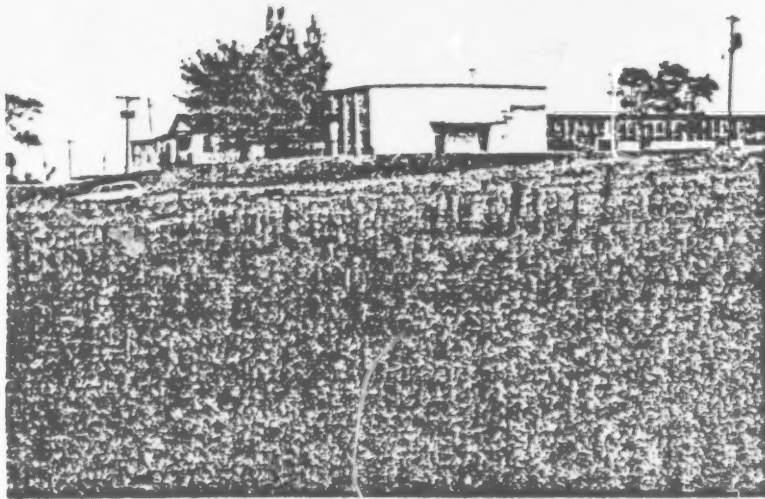
Once the classroom has been developed and the students begin to use it, they begin to see life cycles in action, in the making of humus in the planting of seeds, in the growing, flowering, fruiting and harvesting----gradually patterns and relationships between all living and non-living things begin to emerge in the individual student's mind.

Many teachers feel a heavy responsibility for teaching content subject matter. They know there's validity in the old saying that "a picture is worth a thousand words". The outdoor classroom provides the opportunity for the picture, plus the words, plus "hands

on" reinforcement experiences to seat the learning such that it becomes a part of the learner for many years.

As students become intimately involved in soil, their plants, their animals, an attitude of caring and reverence for living things becomes apparent. They begin to see where they fit into nature's plan and they want to fit. The attitudes and values which are formed here in these early school years will carry over in the decision making of the leaders and voters of tomorrow!





The outdoor classroom expands the learning environment readily accessible to students and teachers. Its use requires no special permit, no time consuming arrangements for transportation, lunches, comfort facilities and no shifting of class schedules. More important, it is immediately available for continuous studies, for an unexpected observation, for supervised individual study projects, and for capitalizing on the "teachable moment". Students learn how their decisions and behavior affect other living things and how people are affected by the way they use soil, water, air, and other living creatures. As they acquire knowledge and understanding from and about the environment, they also develop some competence in evaluating alternatives for using and managing resources.

Every child fits in the outdoor classroom, and every child can be successful there. Children who have experienced nothing but failure indoors may fairly

sparkle outdoors and amaze the others with their knowledge of the outdoors. No matter how high or low the intellectual potential of the child, he will be challenged outdoors.

We've said outdoor classrooms motivate students and provide "teachable moments". Outdoor classrooms reinforce basic skill subjects and provide opportunities for the development of an attitude of caring for and protecting the environment while using it in intelligent ways to meet human needs. But what about the individual student's feeling about himself and about others?

Teachers know that self-concept and learning are linked together. The better the first, the more of the latter is usually accomplished. Teachers know, too, that children need to learn how to work together in cooperative ways. Teachers report they have noticed that when they take students outdoors, the children act differently. Students who talk loudly in class, speak softly outdoors. Students who don't seem to care about anything or anybody change as they hold their first "baby chicken" or make some discovery outdoors which they view with awe. There seems to be some kind of hidden link between us and other life forms, children seem especially keen in "feeling" this when outdoors in class, and their behavior changes in positive ways. They work together, cooperate more fully than is usual in the classroom where competition is generally great.

They ask many more questions than indoors because they really want to know about what they are touching, observing, experiencing.

Citizens in the community enjoy seeing children working outdoors. If the classroom outdoors takes on an appearance of beauty from the care given it, the neighbors who live near the school are especially proud. They let the children know they appreciate what they are doing. The children feel closer to their school neighbors. Senior citizens share seeds and advice with young learners, and the "generation gap" becomes a little less great.

With the neighbors keeping a friendly eye on the classroom, with the children feeling it is their own because they created it, the vandalism problem is greatly reduced. This attitude of caring is infectious!

Statewide, teachers report there are very few acts of vandalism on outdoor classrooms developed by the students. In the harsh reality of life in our country as it is today, this serves as an inspiration to all of us.

Outdoor Classrooms - How do you get one?

The decision to develop an outdoor classroom usually comes long after school buildings and facilities are in place on the site. Thus, each classroom is an individualized project. It must be planned according to the size and shape of the area available and to the topography, climate, geologic features, geographic location and special resource problems of that site. And, most important, it must be created by the students with the assistance of adults and not the reverse.

A pre-requisite for the development of any outdoor classroom is at least one enthusiastic teacher. Given that pre-requisite, some helpful hints follow to assist in the creation of the classroom.

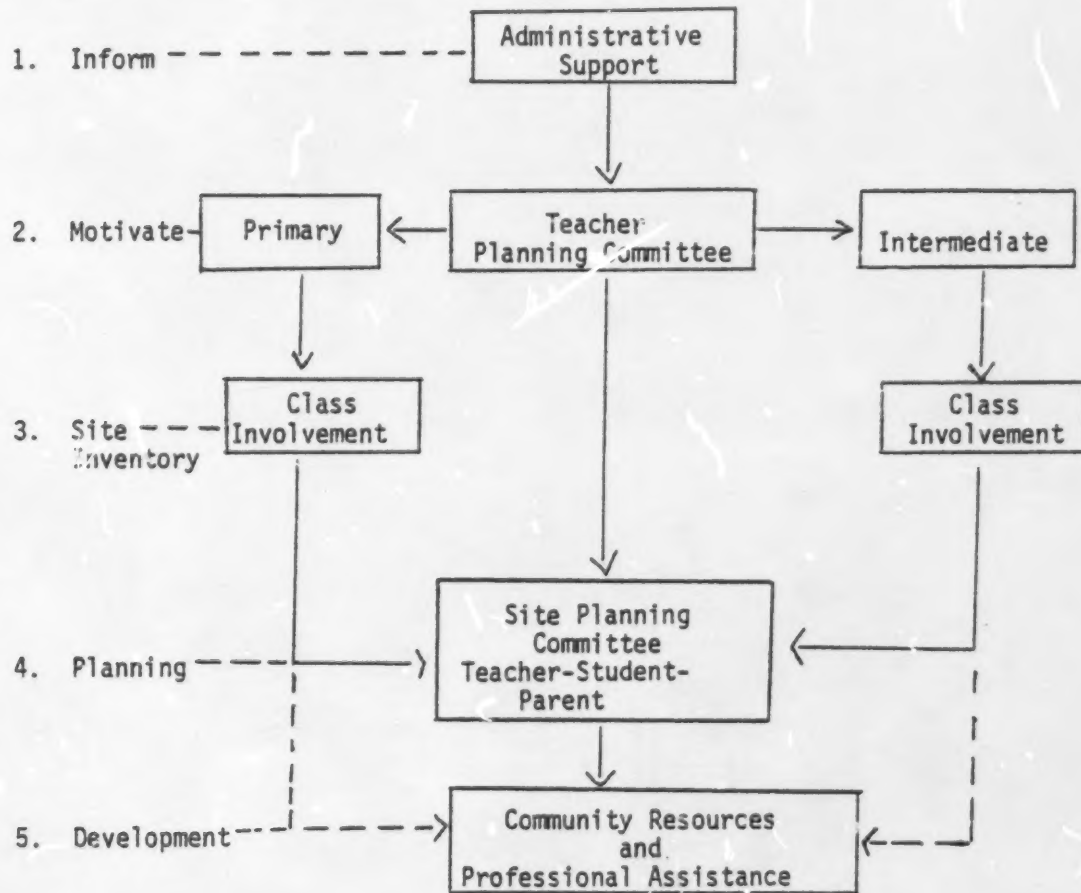
A. Introduction

The following procedures are presented with the intent of giving you a step by step flow of the processes needed to develop the site. The steps are only recommendations and may be adjusted according to your needs. The steps are:

1. Inform
2. Motivate
3. Site Inventory
4. Planning
5. Development

On the following page is the site development flow chart which presents the procedural steps in their recommended order of usage. A description of each step follows the site development flow chart.

B. Site Development Flow Chart



C. Procedures

1. Inform (Administrative support)

- a. One person or a group of volunteers can present the proposal for an outdoor classroom to school administrators. Educational objectives need to be clearly stated, and student benefits from outdoor classroom learning projects should be emphasized. A tentative estimate of costs, in terms of immediate outlay and probable future needs, should be included in the proposal. (You will need to approach your principal for initial approval to proceed with the site inventory and the planning phase.)
- b. A teacher planning committee will need to be formed and composed of at least one primary and one intermediate teacher, students and, if possible, parents.

2. Motivate (Primary - Intermediate teacher planning committee)

- a. A major objective of the planning committee is to become familiar with the school site concepts.
- b. A method to inform other teachers and students should be agreed upon.
- c. Another major objective of every school effort should be children. Therefore, class involvement is vital.

3. Site Inventory (Class involvement)

- a. Each class surveys the school grounds according to their own interest and grade level using the site inventory guide.
- b. The results of this survey will be presented to the site planning committee for discussion and appraisal.

4. Planning (Site planning committee - parents, students, teachers)

- a. Committee compiles results of individual class inventories and sends total results to each class through student committee representatives.
- b. The development of educational specifications for the school site are of prime importance.

Outdoor learning experiences can be developed for many discipline areas, science, math, art, etc. Educational specifications should be developed for resources which are already part of the site, as well as for areas of the site which could be developed.

The following guideline questions should be considered in developing educational specifications:

- a. What is there on the site that should be retained, utilized, and/or modified?
- b. What additional things would you like to see on the site?

Educational specifications should cover the following:

- a. The objective of the activity associated with the site.
- b. How the site will be used (by groups, individually).
- c. How much area is needed.
- d. The spatial relationship to other areas on the site (what, if anything, should it be near or far away from?)
- e. What sort of special equipment will be used that may affect the location or design of the site?

Outdoor Classroom - How do you develop it?

The size of your outdoor classroom will determine the number of persons who will be involved. Frequently perhaps only one or two teachers will initially be interested in helping with the project. It is not necessary for all the teachers or students to be involved in the development of the site in order to have one. Often a portion of the students and teachers will develop the project and it will then become used by a great many more as its value is realized.

The following guidelines may, in part, be helpful in the development of small to large outdoor classrooms. It is important to remember that only a small amount of support will enable teachers and students to be successful in establishing outdoor classrooms. Outdoor classrooms are not expensive to create!

5. Development (Community resources and professional assistance)

The site development should proceed after consultation with the planning committee. This committee will have used the information from the total site inventory and will have developed the educational specifications for the site.

The services of a resource specialist are important in preparing the opening presentation. By making a preliminary appraisal of the school site, he can identify any conservation problem areas that need immediate attention and also those areas that can be developed through student projects.

When administrative support is insured and educational objectives have been arrived at through consultation with teachers of all subjects, the principal or other administrator should name a small committee to take leadership in developing the outdoor classroom.

Continued student involvement should include a sample inventory questionnaire (see sample inventory questionnaire) to determine what the students would most like to see on their site. The responses to this questionnaire would then be tabulated by the planning committee. Perhaps twenty of the most typical answers in the school can be posted on a central bulletin board to be reviewed by everyone. This sample questionnaire could also be given to teachers, community leaders, etc. Other information from community organizations would also be used for future development of the site.

In the development of the site, all community resource specialists should give consideration to the importance of keeping maintenance work down to a minimum. In the development of a good design, careful attention should be given to limiting the size of high maintenance areas.

INVENTORY QUESTIONNAIRE

Student Name _____ Room Number _____

We would like your help to identify some things that you think would be important to have on our site. Do your best in completing this questionnaire. It will help us to do a better job of planning.

1. If you could plan this site yourself, what three things would you add? Please list them in order of preference.

- 1.
- 2.
- 3.

2. After you have decided on what you want, draw a simple map that tells us where you would locate (put) your three selections. Draw your map in pencil first. Then add what you want and where you want it, in pen or crayon.



Developing an Outdoor Classroom (continued)

Throughout the planning and early developmental phases of the outdoor classroom there will be many opportunities for student learning activities. Members of the committee should outline these special learning projects and assign responsibility for their completion. Among the projects that can be planned by and for students are:

- * Mapping, surveying, and measuring slopes; inventorying natural resources.
- * Audiovisual projects to record the history of the outdoor classroom with slides, photos, motion pictures, and tape recordings.
- * Journalism and language arts projects--articles for school papers, features for the local newspapers, programs for local radio and television stations, talks and reports for community groups, and a historical narrative of the development.
- * Industrial arts projects--designing and building learning-trail markers, signs, benches, and other items.

To proceed with the many details of setting up an outdoor classroom, the committee should have the power to delegate responsibilities to individuals or to subcommittees chosen either from the full committee or from other people in the school or community.

One member of the full committee should be authorized to speak for the entire group at school board meetings, to arrange for working with resource specialists and local, state, or federal resource agencies, and to obtain specific plant materials, hand tools, or other

equipment when needed.

Subcommittee assignments might include:

- * Collecting, evaluating, and summarizing published materials from many sources to furnish ideas and suggestions for the outdoor classroom and for learning projects related to conservation education.
- * Organizing and scheduling specific projects and activities for students, teachers, parents, and community cooperators.
- * Enlisting the help of community and civic organizations, resource agencies, and others through a continuing information program that includes talks, slide shows, exhibits, and news coverage.
- * Listing and determining possible sources of materials needed, such as shovels, hoes, rakes, specific plant materials, thermometers, hygrometers, compasses, hand lenses, wind gages, magnifying glasses, collecting bottles, and water- and soil-testing materials.

The inventory items will vary with the geographic location and the size of the school site. Among the things not to be overlooked are:

- * Vegetation--grasses, shrubs, trees, weeds, wildflowers, plants harmful to people such as poison ivy and nettles, and vegetation in old fields for studies of plant succession.
- * Topographic and geologic features--rock outcrops, boulders, slopes, streams, ponds and wet areas.
- * Animal habitats--den and nesting trees, brush piles, food plants, old stumps, and fallen logs.
- * Soil profiles exposed on banks and slopes; potential soil erosion and soil study areas.
- * Historical remnants such as stone fences and old orchards.

- * Sites that would be appropriate for learning trails with study areas and listening posts, for ponds and marshes, and for weather stations and other project areas.

Technical information and services that can be provided by a resource specialist include:

- * Topographic and soil maps showing degree and direction of slopes, drainage patterns, surface water runoff patterns, and soil capabilities and limitations.
- * Preparation of a written plan for the outdoor classroom including suggestions for appropriate treatment and conservation practices and recommendations for alternative solutions to conservation problems; plant materials for specific purposes such as wildlife habitat, soil stabilization, windbreaks, and beauty; a tentative timetable for specific projects such as planting, pond development, trail preparation, and the like.
- * Assistance in laying out work plans and arriving at cost estimates for kinds and amounts of plant materials, grass seed mixtures, fertilizers, mulches, and the like; information on kinds of heavy equipment that may be needed for special projects such as tile lines for drainage, shaping and seeding of diversions, woodland management, and pond and trail construction.
- * Suggestions for sources of additional help from other resource agencies, conservation organizations, or groups such as soil and water conservation districts.
- * Information, booklets, pamphlets, and other material on soil and water conservation practices and related resource management.

This phase of site development involves each interested class surveying the site using either the primary or the intermediate inventory.

A. Primary/Intermediate

The inventory has been written to enable the user to make an assessment of what the site has. It is designed so that it can be done by counting the number of different kinds of species found there. (Salal, blackberry, fir tree, oregon grape, huckleberry, and alder trees)

A teacher's guide and worksheets for students has been included.

It is recommended that the site inventory worksheets be distributed to each student in class and that the directions for the worksheet be read and explained prior to going outside. The class can then go outside and complete the worksheet together with teacher giving directions and guidance. The amount of teacher directions and guidance is dependent upon the ability of the class and discretion of the teacher.

SITE INVENTORY (PRIMARY)

INTRODUCTION

In order to use or develop a site, an inventory of what the site has is necessary.

To make this job easier for you, the following pages are designed as a teacher guide to explain the use of the student worksheets. Each student copy has a short and simple introduction to explain how each activity is to be used. The student worksheets are designed so that you can easily duplicate for class use.

Finally, it is hoped that the design of these inventory sheets will provide you with an adequate "tool" to assess the best potential use you can make of your site.

A. Land

1. Boundaries

Roughly divide the site area into four sections. Walk the length and width of the site area using every step as 1 foot.

Length _____

Width _____

Using the divided square, place the symbols in the proper area.



Area #1	Area #2
Area #3	Area #4



School



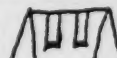
Parking lot



Tree



Shrub



Play area



Baseball field

2. Topography

Choose a designated observation point for each section so that students are using the same vantage points. (Everybody standing in the same spot.) Check the land features that you see:

	Area #1	Area #2	Area #3	Area #4
Hills				
Valleys				
Slopes				
Holes				
*Eroded Areas				

*Eroded Areas: areas in which running water has washed away the soil

B. Animals

Using the total site area, have the students make observations using the check list below.

	Yes	No
1. Birds		
a. nests	___	___
b. signs of birds	___	___
2. Insects		
a. pests	___	___
b. *soil-makers	___	___
3. Mammals		
a.		
b.		
c.		

*Soil-makers - worms, ants, termites, fungi, bacteria, molds (decomposers).

C. Soil

Observe and count the number of elements in each group.

1. Evidence of rocks

few _____ many _____

Shape

smooth _____ rough _____ round _____ sharp _____

2. Soil

a. Color

yellow-brown _____ choc. brown _____ almost black _____

b. The soil is:

wet _____ damp, but not wet _____ dry _____

c. The soil has:

a lot of sand _____ some sand _____ no sand _____

D. Plants

Using the four separate, divided areas on the site, have students record data.

1. Trees

Count the number of trees in each area that have needles, then count the number of trees that have leaves.

Area	Number of trees with needles	Number of trees with leaves
1		
2		
3		
4		

2. Shrubs

Count the number of shrubs in each area that have needles, then count the number of shrubs that have leaves.

Area	Number of shrubs with needles	Number of shrubs with leaves
1		
2		
3		
4		

3. Ground Cover

Look at how thick the grass in each part of the site is and check the boxes.

Area	Thick	Some	Thin
1			
2			
3			
4			

E. Potential for School Site

Generally speaking, the most stable and productive environments are those which have the greatest diversity of organisms, of habitats, and of successional stages. Keeping this in mind and taking the data gathered into consideration, mark which area has the greatest - average - lowest potential for being developed as a site area.

Potential for Site Area

Area	Good	Some	Low
1			
2			
3			
4			

SITE INVENTORY - LAND (PRIMARY)

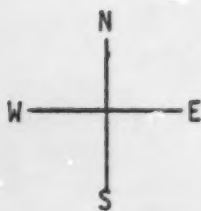
Name _____ Date _____

Walk the length and width of the site area, using every step as 1 foot.

length _____

width _____

Using the divided square, place the symbols in the proper area.



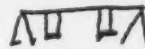
Area #1	Area #2
Area #3	Area #4



School



Tree



Play area



Parking lot



Shrub



Baseball field

SITE INVENTORY - TOPOGRAPHY (PRIMARY)

Name _____ Date _____

Check the land features that you see.

	Area #1	Area #2	Area #3	Area #4
Hills				
Valleys				
Slopes				
Holes				
Eroded areas				

SITE INVENTORY - ANIMAL (PRIMARY)

Name _____ Date _____

Using the total site area, see how many kinds and signs of animals you can find and check in the boxes below.

	Yes	No
1. Birds		
a. nests	☐	☐
b. signs of birds	☐	☐
2. Insects		
a. Pests	☐	☐
b. Soil-makers	☐	☐
3. Mammals		
a.		
b.		
c.		

SITE INVENTORY - SOIL (PRIMARY)

Name _____ Date _____

Observe (look for) and count the number of elements
(items) in each group.

1. Evidence of rocks

Few _____ Many _____

Shape

Smooth _____ Rough _____ Round _____ Sharp _____

2. Soil

a. Color

yellow brown _____ chocolate-brown _____ almost black _____

b. The soil is:

wet _____ damp, but not wet _____ dry _____

c. The soil has:

a lot of sand _____ some sand _____ no sand _____

SITE INVENTORY- PLANTS (PRIMARY)

Name _____ Date _____

1. Trees

Count the number of trees in each area that have needles, then count the number of trees that have leaves.

Area	Number of trees with needles	Number of trees with leaves
1		
2		
3		
4		

2. Shrubs

Count the number of shrubs in each area that have needles, then count the number of shrubs that have leaves.

Area	Number of shrubs with needles	Number of shrubs with leaves
1		
2		
3		
4		

3. Ground Cover

Look at how thick the grass in each part of the site is and check the boxes.

Area	Thick	Some	Thin
1			
2			
3			
4			

SITE INVENTORY - POTENTIAL (PRIMARY)

Name _____ Date _____

After compiling (gathering) this information, all data (information) should be combined (or put together). Then check any of the areas below, that in your opinion, you find to have "good", "some", or "low" potential usage.

Area	Good	Some	Low
1			
2			
3			
4			

SITE INVENTORY (INTERMEDIATE)

INTRODUCTION

In order to use or develop a site, an inventory of what the site has is necessary.

To make this job easier for you, the following pages are designed as a teacher guide to explain the use of the student worksheets. Each student copy has a short and simple introduction to explain how each activity is to be used. The student worksheets are designed so that you can easily duplicate for class use.

Finally, it is hoped that the design of these inventory sheets will provide you with an adequate "tool" to assess the best potential use you can make of your site.

IDENTIFICATION OF RESOURCES

In order to use or develop a site, an inventory of what the site has at present is necessary.

The site area inventory can be best assessed for its environmental quality by counting the number of different kinds of species found in an area, not the number of any one kind. Therefore, this inventory should be kept simple.

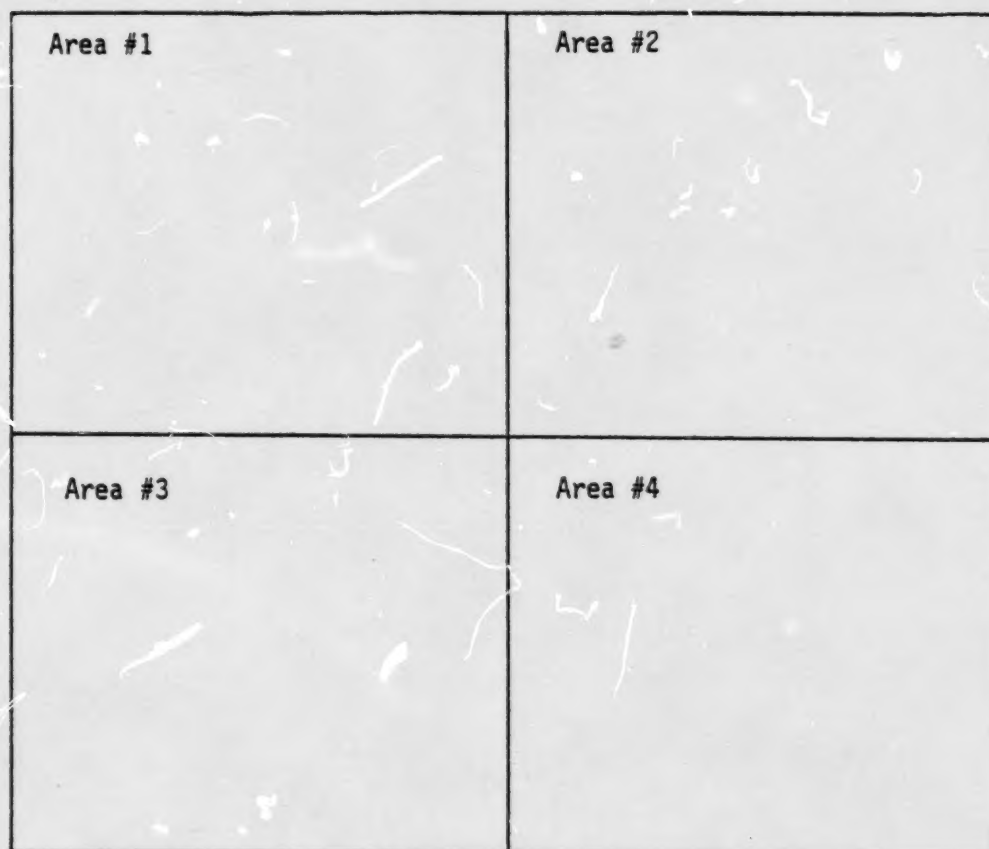
A. Land

1. Boundaries

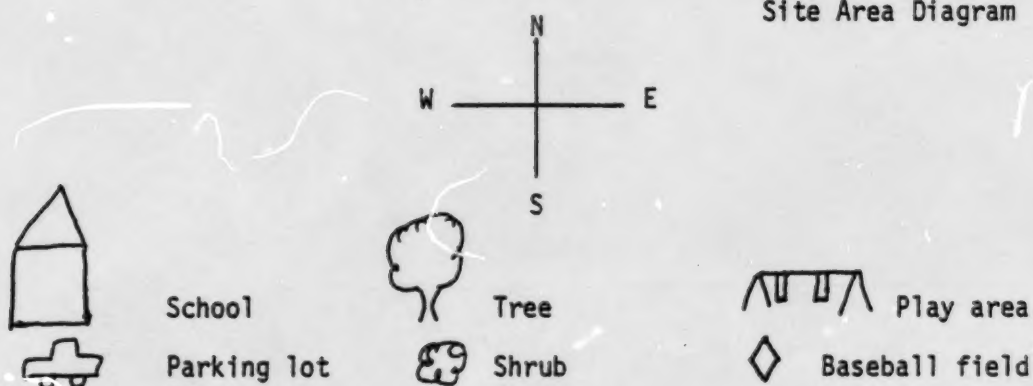
a. Dimensions of the grounds

Length _____ ft. X Width _____ ft.

b. Roughly divide the site into four sections (use site plot plan or step off - every 2nd step = 5 ft.).



Site Area Diagram



c. Place legend symbols on diagram.

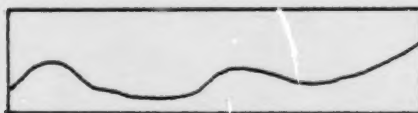
2. Topography - Cross-section of land formations, showing high and low parts.

Choose a designated observation point for each section so that students are using the same vantage points. (Everybody standing in the same spot.) Check appropriate terms for each section,

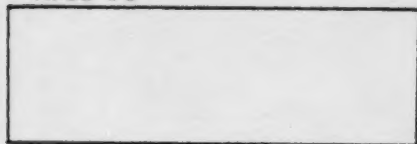
then draw a cross-section from the same vantage point, diagramming the terms checked.

	Area #1	Area #2	Area #3	Area #4
Hills				
Depressions				
Slopes				
Holes				
Eroded areas				

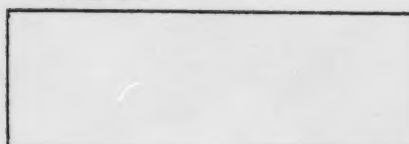
Example:



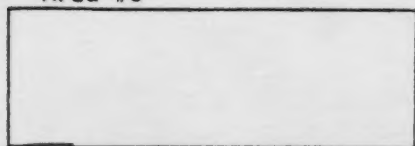
Area #1



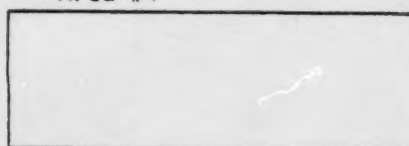
Area #2



Area #3



Area #4



B. Animals

Using the total site area have the students make observations using the check list below.

	Yes	No
1. Birds		
a. nests	_____	_____
b. signs of birds	_____	_____
2. Insects		
a. Pests	_____	_____
b. Soil-makers	_____	_____
3. Mammals		
a.		
b.		
c.		

C. Soil

Using the four separate, divided areas of the site area, have the students observe the evidence of rocks and color, moisture content, and texture of the soil.

1. Evidence of rocks

few _____ many _____

2. Soil

Area	Color	Moisture	Texture
1			
2			
3			
4			

Terms you might want to use:

yellow-brown

wet

sandy

chocolate-brown

damp

gravelly

almost black

smooth

D. Plants

Using the four separate, divided areas on the site area, have the students record data on the number of Evergreen and Deciduous plants in those areas.

TREES

Area	NUMBER OF EVERGREEN	NUMBER OF DECIDUOUS
1		
2		
3		
4		

SHRUBS

Area	NUMBER OF EVERGREEN	NUMBER OF DECIDUOUS
1		
2		
3		
4		

GROUND COVER

Area	SPARSE	SOME	DENSE
1			
2			
3			
4			

E. Potential for School Site Area

Generally speaking, the most stable and productive environments are those which have the greatest diversity of organisms, of habitats, and of successional stages. Keeping this in mind and taking the data gathered into consideration, mark which area has the greatest - average - and lowest potential for being developed as a school site.

Potential for Site Area

Area	Good	Some	Low
1			
2			
3			
4			

SITE INVENTORY - LAND (INTERMEDIATE)

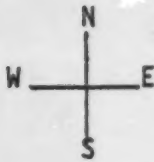
Name _____ Date _____

Step-off the length and width of the site area, using every 2nd step as 5 feet.

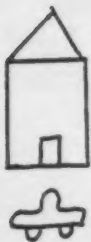
Length _____

Width _____

Using the divided square, place the symbols in the proper area.



Area #1	Area #2
Area #3	Area #4



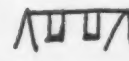
School

Parking lot



Tree

Shrub



Play area



Baseball field

SITE INVENTORY - TOPOGRAPHY (INTERMEDIATE)

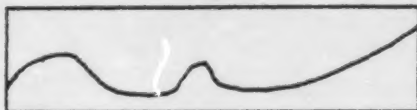
Name _____ Date _____

Check the land features that you see:

	Area #1	Area #2	Area #3	Area #4
Hills				
Depressions				
Slopes				
Holes				
Eroded areas				

Draw a cross-section from the same vantage point, diagramming the terms.

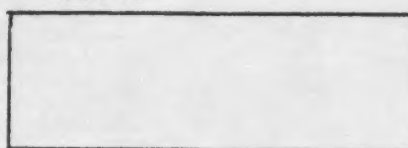
Example:



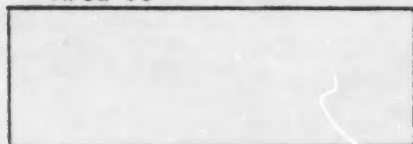
Area #1



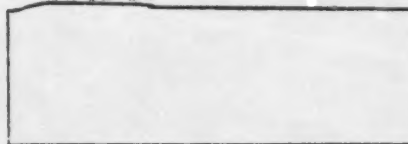
Area #2



Area #3



Area #4



SITE INVENTORY - ANIMAL (INTERMEDIATE)

Name _____ Date _____

Animals - Using the total school site area, determine the presence and kind of animals by checking in the appropriate boxes below.

- | | Yes | No |
|-------------------|--------------------------|--------------------------|
| 1. Birds | | |
| a. nests | ☐ | ☐ |
| b. signs of birds | ☐ | ☐ |
| 2. Insects | | |
| a. Pests | ☐ | ☐ |
| b. Soil-makers | ☐ | ☐ |
| 3. Mammals | | |
| a. | | |
| b. | | |
| c. | | |

SITE INVENTORY - SOIL (INTERMEDIATE)

Name _____ Date _____

Using the four separate, divided areas of the site area, observe the evidence of rocks and color, moisture content, and texture of soil.

1. Evidence of rocks

few _____ many _____

2. Soil

Area	Color	Moisture	Texture
1			
2			
3			
4			

Terms you might want to use:

yellow-brown

wet

sandy

chocolate-brown

damp

gravelly

almost black

smooth

SITE INVENTORY - PLANTS (INTERMEDIATE)

Name _____ Date _____

1. Trees

Count the number of trees in each area that are Evergreen and Deciduous.

Area	NUMBER OF EVERGREEN	NUMBER OF DECIDUOUS
1		
2		
3		
4		

2. Shrubs

Count the number of shrubs in each area that are Evergreen and Deciduous.

Area	NUMBER OF EVERGREEN	NUMBER OF DECIDUOUS
1		
2		
3		
4		

3. Ground Cover

Decide if the grass on each area of the site is sparse, average, or dense. Check the boxes below.

Area	Sparse	Some	Dense
1			
2			
3			
4			

SITE INVENTORY - POTENTIAL (INTERMEDIATE)

Name _____ Date _____

After compiling this information, a conclusion of the data gathered should be made. Thus, check any of the areas below that in your opinion you find to have "good", "some", or "low" potential.

Potential for Site Area

Area	Good	Some	Low

CASE HISTORIES
of the
DEVELOPMENT
of
FOUR
OUTDOOR CLASSROOMS

Outdoor Classroom 1; Tishomingo, Oklahoma

Sid Caperton, high school science teacher at Tishomingo High School, became interested in developing an outdoor classroom after having been a participant in the 1974 Colorado Environmental Education Workshop. In the summer of 1975, he attended a Conservation Education Workshop at East Central State University in Ada and decided he would develop a site at his school.

On learning how to develop an outdoor classroom, he wrote a plan and returned to Tishomingo; and in the fall of 1975, he asked Superintendent Pete Littlepage for permission to use seven acres of land located behind the new highschool which was at that time under construction.

Most of the rather flat seven acres was in meadow with a hardwood forest border. Sid requested and received permission from the owner of the forest to use it in addition to the meadow for outdoor studies.

The District Conservationist, eager to help get the classroom going, prepared a soil map of the site and helped Sid and his students determine where the pond should go. He also provided literature helpful in site development and in teaching on site lessons. In addition, he donated a water testing kit, thermometers, and other equipment helpful in teaching on-site.

Next, Sid and his students asked the County Commission to build the pond. In a matter of days, a small pond had been constructed. After the first rains, Sid's

students brought in native aquatic plants and set them out in and around the pond. They also stocked it with small fish.

Sid's students inventoried their site and decided they wanted to collect as many different Oklahoma trees and shrubs as they could which were not already on the site. A total of \$8.00 was spent for 165 pine seedlings which the students planted on the site. This is the total amount spent on the site so far.

Tools, water hose, and other necessary equipment were provided by the school from supplies on hand.

The area has by and large remained in its natural state with plants native to the area being added from time to time.

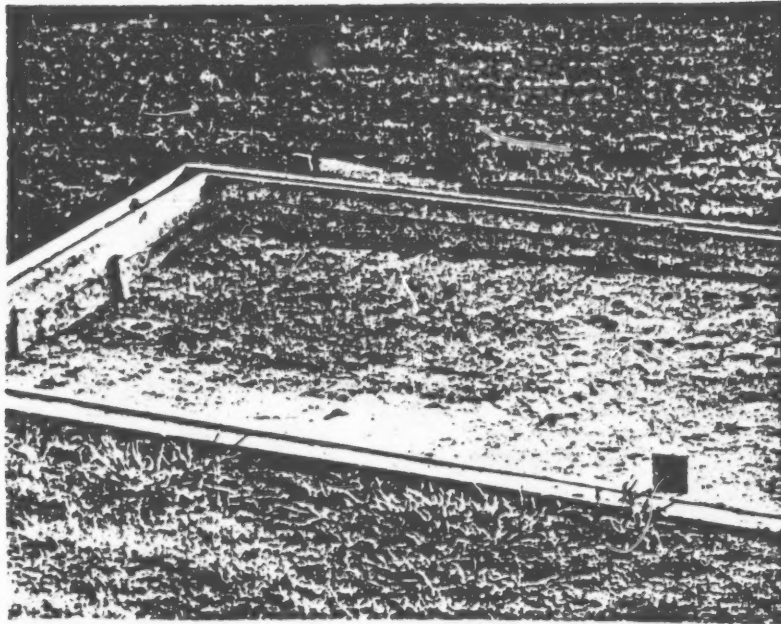
Initially, less than fifty students were involved in creating the site with one teacher, Sid Caperton. These students planted bermuda grass on the pond dam, set out seedlings, helped establish and maintain trails and bring in logs for a quaint "stump seat" classroom under the shade trees on the site. They constructed a bird house and began to study in depth the flora and fauna of their site.

To date, forty-two species of wildflowers have been observed and enjoyed. Rabbits, field mice, gophers, raccoons, coyotes, snakes, frogs, and many insects add variety and interest to the study. The brush-pile left from the pond construction provided habitat for various

forms of small wildlife including good to eat fruit plants such as blackberries.

Of special interest is the rock and cactus garden. Two years ago, geology students became interested in the site, and they and their teacher have brought in samples of rock formations from much of the known geologic periods. The area near Tishomingo is famous world-wide geologically, and Tishomingo students are eager to collect samples and construct mini-cactus gardens, using for each garden samples from a certain period of geologic history. These rocks are arranged in age from oldest to youngest.





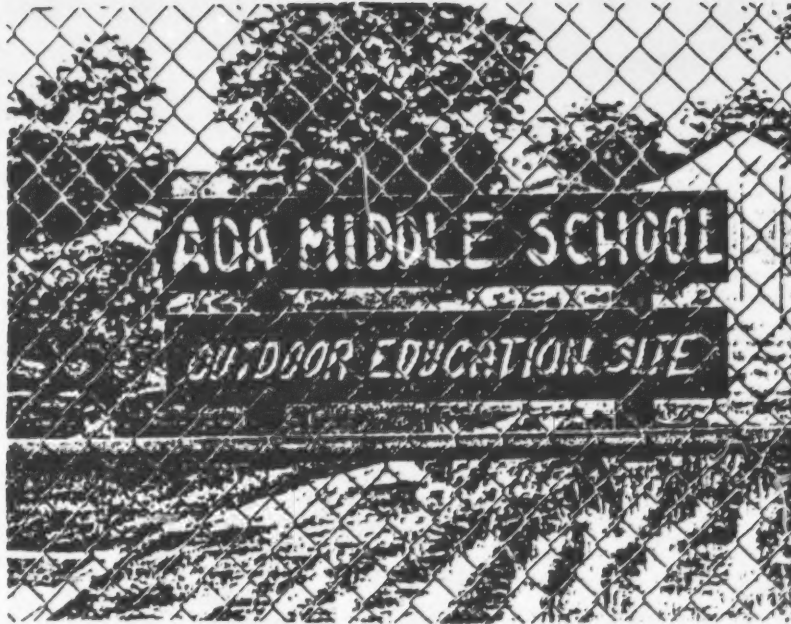
Another high interest spot is the archaeological dig created by the students. About 2 years ago, they buried objects, both organic and man-made artifacts, for the upcoming class. This fall, the "dig" will be excavated and students will explore the remains as the real archaeologists do. Then they will bury the remains and will add something from their "age" for the next class which follows.

As of this time, biology students, geology students, and environmental education students use the classroom. Sid is trying to promote his site so that many other teachers and students will recognize the value of the site and will begin to use it. He has trained high school students to act as guides to help teachers who may bring younger children to visit the site.

There has been no problem with vandalism. There are no fences. Sid feels students' interest and involvement in creating and maintaining the site is responsible for the students' "taking care of" their site.

To Sid, the greatest value of the outdoor classroom is "creating awareness". He expressed amazement at how many students in his rural area have never "listened" to a bird's song, have never studied wild flowers, or observed erosion and its healing or felt themselves an important part of their environment.

The very attractive Tishomingo outdoor classroom is an indication of what can be done when one interested, enthusiastic teacher involves students in authentic learning experiences outdoors.



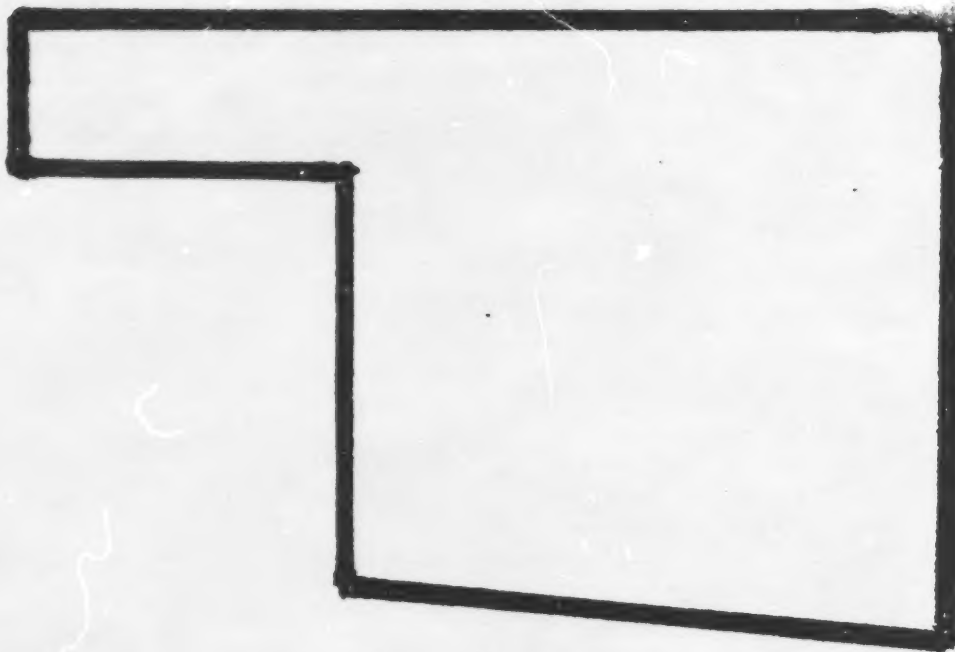
Outdoor Classroom 2; Ada Middle School, Ada, Oklahoma

Pat Kellogg, Ada Middle School sixth grade teacher, became interested in an outdoor classroom as a result of the 1974 Colorado Environmental Education Workshop.

Pat teaches science and math at Ada Middle School, and she felt dissatisfied with the degree of "student involvement" in the indoor classroom setting. She felt sixth grade science should be exciting, inspiring, and very general in nature with a strong emphasis on creating an appreciation of and respect for the delicate natural balances operating in the natural world.

She wanted her students to have the opportunity to experience "cohesive learning" and to uncover natural laws operating in their environment. She wanted them to recognize the impact they themselves have on the environment and the responsibility of caring for and protecting what they would come to cherish.

With these goals in mind, she asked her school superintendent, Dr. Max Skelton, for a piece of school land to be developed as an outdoor classroom. He concurred and staked off a small gravel infested bermuda grass lot across the street from the Middle School next to the school-hours parking area. It was no more than 70' X 150' in size. To allow school buses room to turn around, it came out shaped like this:



Pat asked other teachers to join her and her students, and soon about 350 students and five teachers were busy preparing to transform the bermuda grass lot into "Our Own Little Oklahoma".

The lot was shaped like Oklahoma, except the Panhandle was on the wrong end. The students quickly recognized this and asked to plant their site as a mini-Oklahoma, complete with mountain ranges, streams, rivers, and plants as they occur in Oklahoma.

Quickly they became involved in an intensive bit of research to determine what would go where.

Meanwhile, the local District Conservationist, the O.S.U. Extension Center Soil Scientist, and Dan Sebert, Environmental Education Specialist, ampped the site, tested the soil and provided seeds, plants, and many helpful pieces of literature describing plants to be set out, etc. Four mini-grants given by the Pontotoc County Conservation District helped provide needed funds to develop the project.

Pat grabbed her camera and took color slides of the site in development and of each group who helped.

The Ada City Manager sent his crew with tractor to plow up the bermuda grass; the black clay loam was hard packed and difficult to work with. The students learned that gypsum helps make soil loose, and the Pontotoc County Conservation District supplied funds for 2000 lbs. of gypsum which the children put on the site as they took

out the bermuda grass from the areas to be planted.

"Waste not, want not", and these kids didn't waste. With \$7.00 worth of cement blocks, they constructed a "compose heap". and that bermuda grass was layered with sheep manure, watered down and left to make humus for the upcoming spring garden. Re-cycling was heavily stressed.

The Forestry Department provided shrubs and pine trees; the children planted these in areas marked individually as the "Wildlife Refuge" it represented with tiny mounds, each labeled as the "mountain ranges" it represented. Wild grasses and flowers filled the Pan-handle Area, and Oklahoma rivers became the "trails".

Areas where our natural resources are located were carefully marked with wooden signs as well as our large urban areas.

Some land was left, and the children could plant just what they pleased on it, and they did. Soon corn, peas, beans, squash, pumpkin, okra, cucumbers, lettuce, onions, radishes, carrots, parsley, tomatoes, potatoes, etc., were up and growing.

Recognizing the need for good public relations, Pat, with the help of Dan Sebert, put together a slide-tape program on the "Our Own Little Oklahoma" project. The rationale and objectives of the site were carefully explained, and slides were shown of the work done by the children and others. The local T.V. station and newspaper

picked up the story and gave the project much good publicity. Local patrons were delighted and offered more help in developing the classroom. The community expressed pride in how beautiful the old gravel lot had become. Senior citizens shared seeds, plants, and advice with the students.

The Pontotoc County Conservation District continued with its enthusiastic support. With funds and labor provided by them, a weather station, bird house, and bird feeder were constructed with children helping whenever they could.

The site attracted attention state-wide and because its construction had been well documented, it became part of the work which won a national environmental education award for the Pontotoc County Conservation District in the 1976-1977 school year.

There has not been a single act of vandalism on this urban outdoor site. With the addition of a bird bath, sun dial, aquatic area, picnic tables (seating 35 students), it was decided to fence the area. Today the site sports an attractive 5 ft. chain link fence. The shop teacher, Mr. Aday, and his students are putting the finishing touches on the storage building. The seventh and eighth grade science teachers Mrs. Spencer and Mrs. Hisle, are completing the aquatic site. The home economic teacher, Mrs. Klepper, and her students are planning next spring's vegetable garden.

The special education teacher, Mrs. Tribbey, and her students are picking and eating their "home grown" vegetables. Their zinnias and marigolds are the prettiest in town. Sunflowers provide winter food for birds and the "cash crop" grown by the students.

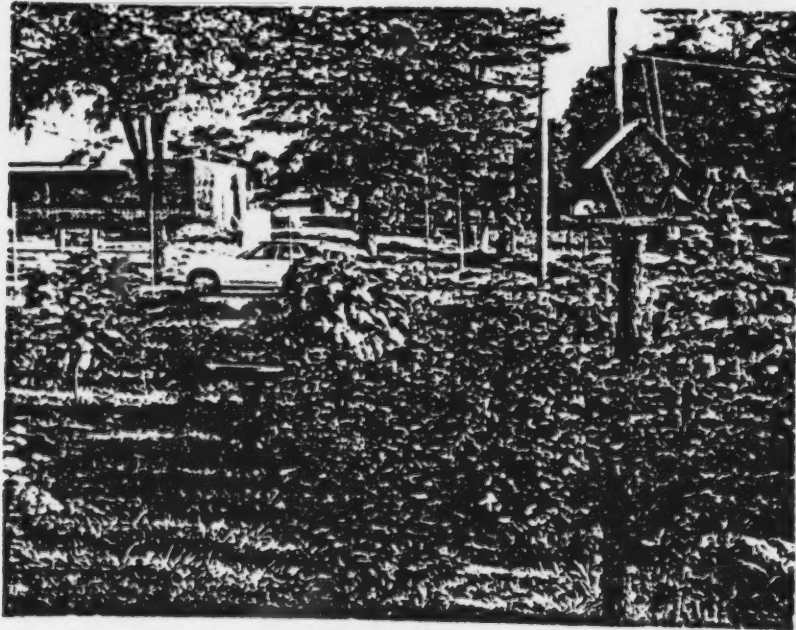
During the last week of school (spring, 1977), sixth graders ate their own "home grown" vegetable salad at the picnic tables and then wrote "thank you" letters to our County Commissioner who supplied the bridge timbers to build the tables.

The Ada administrators have been very supportive of the classroom, and of the teaching philosophy behind it. The school superintendent arranged for the fence, the water, and the construction of the picnic tables.

About once a week in the summer, a small group of students and any one of several teachers may be seen on the site weeding, mowing, taking care of their beautiful wild and domestic garden. Each summer 35-40 students volunteer their services to help care for their garden. Teachers are generous in giving their time and in developing closer relationships with these youngsters.

A small piece of the garden is left to erode each fall. The students learn about "watersheds" and their value and how to heal eroded slopes. They plant rye grass in contoured rows, heal the erosion, and stop the loss of topsoil into the aquatic area. Pat and other teachers at her school feel these kinds of experiences

will have lasting value for their students. The Outdoor Classroom is an important and very popular part of the curriculum at Ada Middle School.





Outdoor Classroom 3; Vanoss, Oklahoma

The Outdoor Classroom at Vanoss, Oklahoma, was begun by Superintendent Clemon Stone at the urging of Environmental Education Specialist Dan Sebert. Mr. Stone encouraged teacher Lorene Turner to attend the 1976 session of the Conservation Education Workshop to receive training in developing the site. Their dream was to change an unsightly public dump into an attractive, useful Outdoor Classroom. This dream is well on its way to being realized to the delight of patrons, students, teachers, administrators, and neighbors in the rural community.

Healing an unsightly dump is certainly worthwhile in any community; however, Vanoss educators saw a need for students to become intimately involved with the outdoors. Although Vanoss is a rural community, many of the students' parents chose to live there because it afforded country living and not because they were farmers. In fact, these air-conditioned homes inhabited by these children provided much of the same environment as that of city dwellers. Students were afraid of the outdoors and its inhabitants and were not sensitive to the patterns and relationships operating in their natural world.

Reaching this second and very important goal took careful planning. High school students who loved the outdoors and spent much time hunting and fishing in woods and ponds were encouraged to share what they had

learned with the others. At the same time, all the students were taught the value of wildlife conservation. In addition, Lorene Turner, high school science teacher, was given two hours release time daily to work with elementary children in their classroom helping them learn how to use the outdoor classroom. Of the nine existing elementary classes, she was invited to help in five during the first year of outdoor site development. Her goal was to teach these children and at the same time show their teachers what can be done hoping they would then feel more like going out next year with their new students for outdoor experiences.

With Lorene's help, teachers learned that taking kids outdoors was not just "play", but as important concepts such as "adaptation" are taught outdoors and understandings of basic science concepts are developed - important attitudes may also be developed. Lorene spoke of the attitude of respect for and caring for the environment as of great importance as she worked with these young children.

While Lorene was in summer school, her superintendent asked the County Commissioner to provide heavy equipment needed to landscape the site. A basic landscaping plan had been provided by the Soil Conservation Service. Patrons of the school brought in pickup trucks and hauled off most of the trash. Students helped in loading and hauling the trash to farmers' gullies to

help slow erosion on their land.

When school began in the fall of 1976, planning for the site began with wider student and teacher involvement. Dan Sebert and the District Conservationist were on hand regularly providing technical assistance, literature, mini-grants, and encouragement.

Most of the four acre plot was put to grass because there was an adjoining forest which belonged to Lloyd Freeman, Junior High Principal at Vanoss. He encouraged the students to use this as their forest community. Clay Jones, Vo-Ag. teacher and his students built a fence crossing into the wooded area, seeded the site, and planted pine trees provided by the Weyerhaeuser Industry.





Special education teacher, Norleen Groves' students constructed bird houses and placed them in and near the forest community for bird habitats and study. Patsy Young, sixth grade teacher, and her students constructed a small aquatic area and a small weather station was installed nearby.

Using aerial soil maps and the "Soil Study of Pontotoc County" booklets, Cotton Holland and his FFA boys worked to develop the site. Much labor was provided by these students. Their special project was a wild grasses plot which they established. George Wright and his junior high science students are in the process of constructing a rock garden as their special project.

Picnic tables have been constructed with the hope that both students and neighbors will use the area for recreation. Approximately 1/3 of the meadow area was left to be "natural" at the request of Lorene Turner. Her students are establishing "wood chip" trails through this part of the site. The wood chips were donated by People's Electric Cooperative. Gloria Bussey and her seventh grade students took advantage of the aquatic area and a nearby pond to do extensive water studies.

A great many of the students were involved in the 1976-1977 school year, and more are expected to become involved this coming school year. Cooperation between teachers, students, patrons, and administrators has been very good.

As for vandalism, there has been none. When asked why not, Lorene stated that she felt it was because the site belonged to the children since they had done most of the planning and the work. She felt the kids' attitude was one of "I made a difference; it's mine, and I don't want to see it messed up." Littering on the school grounds has also been reduced.

The Ada Evening News and KTEN T.V. gave this project considerable support from the beginning. Attractive signs made by Tommy Thurman and his woodshop students made the first page of the newspaper. "Patrons must be proud of this project," Lorene stated, "else we certainly would have had some complaints on the day of the first

grade "Treasure Hunt." It seems that the only plants which the kids found to meet the criteria for the hunt were prickley pear cactus. Unknowing to Lorene who led the hunt, first graders picked the cactus and put it in their pants pockets. One first grade student began to come out of her clothes in dismay. "If parents can handle that," stated Lorene, "they certainly must feel this outdoor school is a good thing for kids."



Our Little Paradise.
 Environmental study.
 Inquiry science.
 Classroom without walls.
 Outdoor laboratory.
 Environmental study.
 Stop spots for nature's
 kaleidoscope

Outdoor Classroom 4; Wewoka Elementary School, Wewoka, Oklahoma

These are teachers' tags for the Wewoka Outdoor Classroom, an unusual 7-acre hillside where pupils study the environment while in the environment.

It's a world of tadpoles, lizards, frogs, crawdads, bird nests, anthills, rocks, trees, pond, birds, trails, wild fern, flowers, weeds.

The whole school - 600 elementary pupils, grades one through six - is involved in the outdoor classroom with pupils, sometimes two grades at a time, rambling over the area at least once a week fall, winter and spring.

The outdoor classroom, now in its third year, was made available to the Wewoka Elementary School by Wewoka businessman Albert Norvell.

The area, adjacent to Bluff View Park, a city park in southwest Wewoka, is within walking distance of the school.

Most of the study is concentrated in 1-1½ acres, Mrs. Neva Chelf, science teacher, said. She is project coordinator.

She was instrumental in organization of the outdoor classroom project, which has received national attention for teaching innovations.

The National Science Foundation helped initiate the project in 1973 when five elementary teachers attended a three-week earth science instructional workshop at Canon City, Colorado.

The teachers conducted a workshop for other Wewoka teachers.

All of the materials and funds used for development of the outdoor classroom have been provided by Wewoka citizens.

The Seminole County Conservation District provided materials for the rustic wooden sign which marks the classroom site and Wewoka teacher Jim Lawson supervised construction.

Mrs. Chelf's husband, John, district conservationist, helped with the project development. The elementary principal, Mrs. Camilla Nash, and other faculty members worked on development of the program.

Study reaches beyond nature and science. Pupils write poetry in the scenic setting. Wood and rocks appear in art work. Math students figure the number of board feet in a tree (there are 25 different species) or calculate the thickness of a single leaf.

There are exercises in sound awareness, stone identification, "trust" walks with blindfolds.

Pupils learn to identify poison ivy and poison oak.

"We watch the seasons change," Mrs. Chelf said.

The pupils especially enjoy hearing the cardinals sing or watching redwing blackbirds swoop down over the pond.

There's a specific task or project for each grade. The first graders outlined with rocks a trail to an old dairy building and made a rock garden.

The second grade planted canna bulbs. When tools were needed pupils saved trading stamps and bought shovels and other tools.

Third graders are in charge of the pond; the fourth, bird feeders; and the fifth, the weather station.

Sixth grade pupils are in charge of mapping and general maintenance of the grounds, taking care of the fence and gates and identification markers for trees.

WHERE TO GET INFORMATION ON CONSERVATION ACTIVITIES

The Soil Conservation Service, Extension Service, and Forest Service of the U.S. Department of Agriculture are among the federal agencies that can assist in developing outdoor classrooms. These agencies have either regional, state, or local offices. Telephone directories list these offices under "United States Government."

Many national and state conservation organizations, industrial associations, and citizen groups have local chapters or units that will help with conservation projects. The Conservation Directory (152 pp., \$1.50), revised and published annually by the National Wildlife Federation, lists many of these organizations.

American Forest Institute
1835 K Street, NW
Washington, DC 20006

American Forestry Association
919 17th Street, NW
Washington, DC 20006

Conservation Education Association
Post Office Box 450
Madison, WI 53701

Conservation Foundation
1250 Connecticut Avenue, NW
Washington, DC 20036

Izaak Walton League of America
1326 Waukegan Road
Glenview, IL 60025

National Association of Conservation Districts
Davis Memorial Conservation Library
Post Office Box 776
League City, TX 77573

National Audubon Society
1130 Fifth Avenue
New York, NY 10028

National Council of State Garden Clubs
4401 Magnolia Avenue
St. Louis, MO 63110

National Wildlife Federation
1412 16th Street, NW
Washington, DC 20036

Nature Conservancy
1800 North Kent Street, Suite 800
Arlington, VA 22209

Soil Conservation Society of America
7515 Northeast Ankeny Road
Ankeny, IA 50021

Teaching Organic Gardening
Rodale Press, Inc.
Emmaus, PA 18049

The Wilderness Society
729 15th Street, NW
Washington, DC 20005

Tips and Tricks in Outdoor Education
Malcolm Swan
Interstate Printers and Publishers, Inc.
Danville, IL 61832